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CONTENTS:

Recent Advances in the Teaching of Physics: PROFESSOR HENRY CREW 481

The Science of Smoke Prevention: PROFESSOR CHAS. H. BENJAMIN 488

The Cardinal Principles of Ecology: PROFESSOR W. F. GANONG 493

Scientific Books:—

Palmer's Index Generum Mammalium: J. A. A. *Newstead's Monograph of the Coccidae of the British Isles:* T. D. A. COCKERELL 498

Scientific Journals and Articles 502

Societies and Academies:—

The Geological Society of Washington: ALFRED H. BROOKS. *Section of Biology of the New York Academy of Sciences:* PROFESSOR M. A. BIGELOW. *The Academy of Science of St. Louis* 502

Discussion and Correspondence:—

Instability of the Water Supply of the Rio Grande: DR. F. S. DELLENBAUGH 505

Special Articles:—

Biological Survey of the Waters of Southern California: PROFESSOR CHARLES ATWOOD KOFOID. *The Necessity for Reform in the Nomenclature of the Fungi:* DR. F. S. EARLE. *Energetics and Mechanics:* PROFESSOR FREDERICK SLATE 505

Quotations:—

President Eliot 5 2

Notes on Inorganic Chemistry:—

Water Gas in the Chemical Laboratory; Yellow Arsenic; Copper Cyanid Solutions; Corrosion of Iron Water Mains: J. L. H. . 513

A Quarterly Issue of the 'Smithsonian Miscellaneous Collections' 514

Botanical Work in the Philippines 516

Scientific Notes and News 516

University and Educational News 519

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*RECENT ADVANCES IN THE TEACHING OF PHYSICS.**

THIS is an hour when anything but congratulation is impossible, not alone for this queenly city seated at the foot of the majestic Front Range, but for the entire commonwealth. The foresight as well as the generosity of the donor in aiding an institution which had already richly deserved such aid, the skill and taste of the architect, the adaptation of the laboratories to the needs of modern science, these all command our admiration. The manner in which a quarter of a century has transformed a mountain foothill into an educational center challenges the respect of every one.

From a sister university on the eastern slope of the Mississippi I bring to your president and to his staff greetings and all good wishes. I bring them no reminder of the responsibility which always accompanies opportunity such as is represented by this building, for there is probably, in all the land, no group of men more keenly aware of the fact that endowment and duty are close friends. No one knows better than the men who have this work in hand that not to advance is to recede.

Times are not so simple as they were even twenty-five years ago, and we are finding ourselves daily more and more in the position of the red queen in the Alice books where 'it takes all the running you can do to keep in the same place.'

* Paper read before the Science Conference held at the dedication of Palmer Hall, Colorado College, February 22, 1904.

But change does not always spell advance, and not every novelty is an improvement. It may be well, therefore, before we consider progress along any particular line, to recall what constitutes progress in general. The profound studies of Mr. Spencer led him to a very happy definition of progress, namely, 'an increase in the adaptation of man to his environment.' This description would be eminently satisfactory were it not that in another place Mr. Spencer characterizes progress as a 'benevolent necessity,' thus robbing it of every element of human initiative and of conscious endeavor. For this reason many of Mr. Spencer's most ardent admirers—among whom I count myself—while admitting the happiness of his phrasing, will nevertheless prefer the view of Professor Karl Pearson who regards progress as the result of a distinct program, the outcome of plans laid with care and according to the soundest biological principles.

Having in mind this point of view from which progress is a consequence of deliberate forethought, I invite your attention to some of the advances recently made in the teaching of physics to English-speaking students.

Let us use the word 'recently' as referring to the last thirty years and consider *first* some advances in the *teaching* of physics which have resulted from advances in the *science* of physics.

I. IMPROVEMENTS IN MATERIAL.

The purchase by Princeton College of one of the Gramme machines exhibited at the Centennial Exposition in 1876 may, perhaps, be fairly considered as marking the introduction of the modern dynamo into the American physical laboratory. Only five years after this date I found myself a student in this laboratory which had purchased the Gramme machine—an excellently equipped and ably directed laboratory, then as now. A single illustration must suffice to show how matters have changed. On turning the pages of my first-year note-book, I find that one of the experiments assigned me was the measurement of the current furnished by this Gramme machine under certain definite conditions. This was done in two ways: (1) the earth's horizontal magnetic component was determined at a certain point; at this particular point was placed a tangent galvanometer whose constant I had computed; the deflection which the current produced in this instrument completed the data necessary to determine the current in webers. Amperes were yet novelties, not to say mysteries. The graded galvanometer and the ampere-balance of Kelvin were not yet on the market. The beautiful instruments of Weston were unknown. (2) The second method employed was to assume the electro-chemical equivalent of copper and proceed to measure the average current by weighing the amount of metal which it had deposited.

Each of these processes proved highly instructive, and they are cited merely to show the amount of time and detail which the student was driven to consume when for any reason he wished to know the value of the current he was using; for the 'working constant' of the galvanometer carried about the laboratory was by no means so constant as its name might imply.

Another forward step was marked by the introduction of the low-resistance, portable D'Arsonval galvanometer which permits the elementary student, at his own laboratory table, to study practically all the fundamental properties of electric currents; this with an outfit which is simplicity itself, and at a cost which brings the entire equipment easily within the range of the most modest high school. The point here, let me insist, is not the increased convenience and comfort of the student,

but rather the power which it confers upon him of devoting his energies to those phases of the subject which are under investigation, those topics which for the time being have become really fundamental.

Among other improvements in this direction there came after the dynamo, in rapid succession, like a host of beneficent corollaries, the electric motor, the arc lamp, the incandescent lamp, the storage cell, the powerful magnetic field, the transformer, the electric furnace, the electrolytic interrupter, the oscillograph, each opening up hitherto-undreamed-of possibilities in the way of demonstration for elementary students and of investigation for advanced students.

I shall not detain you further to illustrate a point which is, perhaps, more familiar to many of you than to me. Let me only mention, as opening up new possibilities for the student, the platinum thermometer, the high temperature mercury thermometer, the Rowland grating, the Wallace-Thorpe replica, the interferometer, Jena optical glass, quartz ware, the cheap production of aluminium, platinum mirrors, isochromatic dry plates, and so on almost without end.

But if these devices have aided undergraduate instruction, what shall we say of the student advanced to the point where he is ready to take up a piece of research? For him they have rendered problems soluble, by the hundred, which previously lay in the region denoted by Mr. Gladstone as 'outside of practical politics.'

But best of all the discoveries which the last generation has made concerning the merely mechanical side of teaching physics is the fact that practically all the fundamental—and many even of the more recondite—principles may be demonstrated with apparatus of the utmost simplicity. One condition only stands between the simple material outfit and success, namely, an instructor who is so thoroughly master of the subject and of the situation that he will see that the student gets from his outfit all the information and all the training intended. The older any man becomes, the more he admires simplicity, and especially the simplicity of nature (our ever-present model), of whom Fresnel remarked: 'She never balks at the difficulties of analysis, but always hesitates to employ methods which are complicated.'

The nations of light and leading have made a capital discovery just at the close of the nineteenth century; they have just awakened to the fact that they can 'go in and possess the land' more easily when they have at home an intelligent rank and file, an educated parliament, a scientific government, a free and happy electorate. So also in the teaching of physics a capital discovery has, I think, been recently made in the fact that armament is not everything. No number of expensive and elaborate demonstrations, no striking exhibitions of machinery can ever replace the simple experiment, the lucid and orderly presentation of phenomena, the distinct effort made by the student to grasp the essential principle, or the conscious effort at accurate observation and judgment called forth by an ambition to get from a simple device the best attainable result and the simplest possible point of view. There is danger in any instrument when it becomes so perfect and so accurate that the young man who is working with it is tempted to degenerate into an 'organ-grinder.' The accuracy in a laboratory should not all be confined to its machinery; some should be left for the judgment.

It was, therefore, no small step in advance when the instructor came to see clearly that all he can ask of a piece of apparatus is that it shall be capable of yielding the results which he demands of the student, and conversely that he can

not hope to train the student in habits of precise thinking without demanding of him nearly the best which the apparatus can give.

With such an undoubted improvement as the advent of the student laboratory, it was inevitable that some enthusiastic admirers should push it too far. In the earlier days mistakes were undoubtedly made in thinking that if once a laboratory could be established and once the student gotten into it, his scientific salvation was immediately insured, if not, indeed, already accomplished.

But now the pendulum has swung back; the days of 'organ grinding' in the laboratory have largely ceased, and I reckon it not least among recent advances in the teaching of physics that the modern instructor has learned that an undergraduate can not be simply turned loose in a laboratory. Much forethought, indeed, is demanded in order that during laboratory hours the instructor may keep quiet and the student keep busy—and keep busy not on any haphazard problem, but keep busy on a *series* of problems so graded that, by solving them in order up to any point, he has developed the power of intelligently undertaking the next. Carefully planned courses of this kind are to be found in many laboratories, every one of them a powerful aid toward putting a young man into a position where he always 'knows what to do next,' which, as President Jordan has admirably remarked, constitutes a liberal education.

II. IMPROVEMENTS IN METHODS.

1. *Introduction of the Energy Treatment.*—Leaving now to one side all questions of material outfit, let us consider some improvements of a still more fundamental nature. I refer to those which have been made in the *method* of teaching. Here it is scarcely possible to believe the changes which a single generation has wrought.

Progress is something to which the Anglo-Saxon takes so kindly that he is apt to forget just what manner of man he was some thirty years ago.

Perhaps I can most briefly illustrate by reading a few lines from Tait's review of Balfour Stewart's 'Lessons in Elementary Physics.' Stewart, as many of you know, was one of the first men to treat physics as a single subject—to treat heat, light, sound and mechanics from the energy point of view—the view which, twenty years before, had, as we now believe, been thoroughly established by Joule, Helmholtz and Kelvin. This review was published in *Nature* December 29, 1870. Here is what Tait says: "This is a bold experiment and decidedly deserves to be a successful one. * * * It is scarcely possible to form a judgment as to the probable success of the present work. It is so utterly unlike anything to which we have been accustomed that we can only say that we never saw such a work in English at least. * * * The reign of inartificiality and simplicity must soon be inaugurated and this work will greatly tend to hasten its advent."

These are the remarks of an experienced teacher and able investigator concerning a text-book which to-day we all recognize as eminently natural and simple. So familiar are we with the energy treatment that we are apt to forget how recently these 'watertight compartments' existed in physics as they yet do, according to the gospel of John Perry, in the department of mathematics.

But, after all, the energy view-point is merely the outcome of the Lagrangian dynamics and Helmholtz's little tract on the 'Conservation of Energy.' Trowbridge's 'New Physics,' appearing some twenty years ago, did excellent service in furthering this standpoint.

The introduction of the energy idea did

more than merely unify the subject; it placed in the hands of the teacher the possibility of making a really simple and logically-arranged presentation of his subject, a presentation which had been in vogue among the classicists for many years, and possibly the only presentation which could make the experimental study of physics a genuine training for power.

In the domain of higher physics, the work of J. J. Thomson, in 1887, on the 'Application of Dynamics to Physics and Chemistry' may fairly be considered as marking an epoch in the energy treatment and in the unification of physical science. Equally impressive are the three volumes containing the proceedings of the International Congress of Physicists at Paris in 1900. One turns the entire two thousand pages of this report without feeling the slightest discontinuity either of subject or of method, from the dynamical papers at the beginning to the electrical papers at the end.

2. *Introduction of the Student Laboratory.*—But of all reforms in method the most revolutionary was the introduction of the student laboratory, which came in at about the same time with the energy treatment.

To be sure, especially favored students have always been admitted to the private workshop of the master, but it is only within the last generation that *students in general* have obtained similar privileges.

In a letter to *Nature*, dated January, 1871, Professor E. C. Pickering describes the new physical laboratory of the Massachusetts Institute of Technology, where he was then an instructor, and proceeds to add: 'There are now in America at least four similar laboratories either in operation or in preparation and the chances are that in a few years this number will be greatly increased.'

How amply this prediction has been fulfilled may be realized when we consider that America has to-day more nearly four hundred fairly equipped physical laboratories.

In this connection it is well for those of us who are inclined to be optimistic to turn now and then to Professor Pickering's 'Physical Manipulation,' the only English laboratory manual available in my undergraduate days, and see how thoroughly modern his treatment remains. Confessedly the problems are not graded exactly as we should do it to-day, yet in spirit, in method, in economy of teaching energy and in sound learning these two volumes may well give us pause, and make even the most sanguine ask whether evolution is not a provokingly tedious process.

Let no one infer, however, that improvements in method are entirely illusory, for the present-day instructor in physics certainly has in mind more clearly than any before him just what the goal is and just what the method of approach. He knows full well that no student can work out his own salvation while seated in a comfortable auditorium chair, observing a speaker manipulate certain curious apparatus with certain curious effects.

3. *Lessons Learned from the Engineer.*—The modern instructor has learned also to take advice from the engineer—this too without bowing to the immediately useful and without substituting mere knowledge for intellectual power. He realizes that centrifugal forces, centrifugal couples and the energy of rotation may quite as well be studied from bicycles and the driving wheels of a locomotive as from an ellipsoid strung on a knitting needle. Electrical *science* and electrical *engineering* were at one time much farther apart than they are to-day; the engineer and the physicist are closer friends than they were twenty-five years ago.

Perhaps neither all the phariseeism nor all the charity has been confined to one

side. America's two leading physicists were each educated in engineering schools, the one at Troy, the other at Annapolis.

Helmholtz says: 'Action alone gives a man a life worth living, and, therefore, he must aim either at the practical application of his knowledge or at the extension of the limits of science itself.'

Here we have, at once, the justification of the engineer and of the investigator—a view which has, I believe, been accepted by many instructors greatly to the advantage of their method.

Briefly, then, the marked improvements in method have been: (1) The introduction of the energy viewpoint, thus securing unity and simplicity of treatment; (2) the introduction of the student laboratory, and (3) the introduction of more concreteness; this last being a beneficent reflex influence from the engineering side.

III. MEN.

Passing now to the men who have been and are teaching physics in America, the word 'progress' raises a difficult and almost insoluble problem. At any rate, I shall asume that we *all* agree in putting the main emphasis upon the spirit and ability of the instructor. The fundamental difference between laboratories is, indeed, after all a difference between men. What they call at Berlin 'die Glanz-periode der exakten Wissenschaften'—the years immediately following the Franco-Prussian war—was essentially the product of four or five men, Virchow, du Bois-Reymond, Hofmann, Kirchhoff and Helmholtz.

I may as well at the outset confess myself a hero worshiper and say that my respect for the university instructors of the preceding generation—some of whom I met during nine years at Princeton, Berlin and Baltimore—is so nearly unbounded that I dare not think the talent engaged in teaching physics to-day is, in any important respect, superior to that of the recent past.

When, however, we turn to the average college instructor or to the average high school instructor it becomes patent that the entire situation has changed. Recent developments in physical science and the duplication of instructors have driven men to specialize. As Professor Runge once said to a meeting of astrophysicists at the Yerkes Observatory: 'Nature is becoming more and more disorderly every day!' The young teacher without special training navigates uneasily a stream beset with small craft hailing him for information about the trolley line, about the automatic telephone, about the transformer, about liquid air, about radium.

The modern instructor in physics—and I dare say the same change has occurred in other sciences—is first of all a man who has shown his ability to widen the borders of human knowledge. Power to investigate is becoming more and more a first criterion for his ability to teach. (Shortly it will be a necessary criterion.) In any event he is a man who has an intelligent interest in and an active sympathy with physical research.

In the *second* place, he is a man with a keen Greek perception of relative values, a cultivated sense of proportion, always subordinating mere facts to methods, always placing the power of clear thought above any amount of mere knowledge.

Again he is frank and fearless in the confession of ignorance, but only after he has made every effort to bring this ignorance to a minimum.

The modern instructor does not trifle with atoms, molecules and other hypothetical creatures which he has not seen and does not know about. He takes pains to point out the line of demarcation between the known and the unknown, believing that few things are more instructive for

the learner than the limitations of human knowledge concerning even household matters. As a boy I was taught to respect Newton as the man who had explained gravitation; to-day the lad is taught that Newton distinctly refused even to make a guess at its explanation. With equal piety, I was taught that there are six kinds of electricity, all mysterious and imperfectly understood; but it was never hinted in those days that we are no less ignorant of what carbon or what copper is than we are as to the nature of electricity.

Illustrating this point, I have long maintained that one of the most scholarly men I ever met was a motorman on a trolley line running out of Denver some thirteen years ago. I was at the time visiting the then new University of Denver. And seeing what appeared to me an *extra* wire suspended above the trolley, I stepped to the forward end of the car and inquired as to its purpose. I shall never forget the reply of the man as he turned his frank countenance toward me and said: 'My dear sir, all I know about this is just enough to turn on the juice and let her buzz!'

Still again the instructor in modern physics is a man who believes in the careful scrutiny of all the data which enter into an argument, and in the avoidance of reasoning from insufficient data—the 'bastard *a priori* method' as described by Spencer. The modern laboratory instructor is a man whose ambition for his student is that in the presence of physical phenomena he shall maintain a certain mental attitude of independence, a habit of observation, inquiry, experiment and judgment, that he shall acquire what is known in military circles as skill in scouting.

The difficulty of these tasks was not first pointed out either by Longfellow or by Goethe; for Hippocrates* had already remarked that: 'Art is long, time is fleeting, opportunity brief, experiment difficult, judgment uncertain.'

In conclusion we find that improvements in the teaching of physics have come from three directions, improvements in *material*, improvements in *method* and improvements in *men*. But unfortunately the greatest changes appear to have occurred in the least important direction, namely, that of material; while the least change is visible in the most important direction, namely, in the teaching staff.

So much for the past, but what of the future? The physical and biological sciences have changed the entire face of civilization; they have ameliorated human suffering, they have prevented disease, they have set us free from a thousand and one painful superstitions. Does any one imagine their career at an end? The fact appears to be that in the immediate future these sciences are to become the determining factor in deciding the superiority of nations. Numbers are a *potent* factor, but they are not everything. What a host of phenomena in the South African War are explained by the incident of the Boer father who handed his boy a single cartridge and instructed him to go out and bring in an antelope!

Two duties would, therefore, appear to thrust themselves upon every instructor, every investigator and every patron of science. The first is to see that science is taught in a still more effective manner. The test of effectiveness we must find in the students' ability to *do* something; he must either help us to use the energies of nature to make life easier or he must join the pioneer corps and show us new properties of matter and energy whose usefulness no one to-day will question.

And secondly we who have faith in the scientific method must exhibit the courage of our convictions in seeing that science

* 'Aphorisms,' T. I.

becomes the handmaid, or better still the adviser, of the state.

More than a quarter of a century ago it became evident that stone fortifications are worse than useless in the presence of modern armaments; but as a people we have yet to learn that the stone building which is about to be dedicated is one of the bulwarks of the nation. The executive branch of our government has learned it partially; the legislative branch not at all. I look forward with hope—and even confidence—to the day when science will be in in the saddle, not for science's sake so much as for America's sake.

And it is precisely in Palmer Hall that young men and young women are going to learn that accuracy of speech and thought which is at once the first step in morality and the best preparation for action. *Here, if anywhere,* will be acquired productive scholarship.

Could we have with us the man whose life and character is celebrated to-day throughout this broad land no one would be more enthusiastic than he in applauding the purposes of this institution and in acknowledging our national indebtedness to this and to similar foundations.

Upon the teacher of science, perhaps, above all others falls the duty of insisting with Lotze that 'while the scientific method may not be the royal road to salvation it will at least keep us from straying very far from the path.'

And when on the morrow Old Glory is raised above this beautiful structure let us salute her as marking one of our national defenses.

Henry Crew.
Northwestern University.

The Science of Smoke Prevention.

Perhaps a better statement of the subject would be 'The Science of Perfect Combustion,' for perfect combustion is attended by no visible smoke. It is always best in a discussion of this kind to define terms before making statements. The Century Dictionary says that smoke is 'the exhalation, visible vapor, or material that escapes or is expelled from a burning substance during combustion' while the Encyclopedia Britannica states that 'Usually the name smoke is applied to this vaporous mixture discharged from a chimney only when it contains a sufficient amount of finely divided carbon to render it dark-colored and distinctly visible.' For us who live in the soft-coal belt the definition may be further narrowed down, for when we say smoke we mean the densely-laden fumes from the combustion of soft coal which deposit thick layers of soot on all exposed surfaces. The smoke from hard coal, coke and wood is so innocuous compared with that just mentioned that it may be entirely disregarded in the discussion.

The occasional production of dense black smoke is peculiar to that group of fuels known as hydrocarbons, of which the more common are the petroleums and bituminous coal. The combustion of hydrocarbons seems to be always complete at first. If one watches the slow burning of a lump of cannel in the open grate he will see a whitish or yellowish vapor expelled from the coal by the gradual heat of the fire. This is the carbon and hydrogen combined which is distilled by the heat and leaves behind the free carbon as coke. While the escape of this vapor unburned represents a distinct loss of heat, the vapor is not smoke as we understand it. It does not deposit soot and will not stain or disfigure surfaces in its path.

As the heat increases and air is supplied the vapor ignites and burns with a yellow flame showing the presence of solid particles. If the temperature remains high and the air supply continues, the combustion is complete and the colorless carbon dioxide and water vapor pass up the chim-

ney. If, however, the burning gas becomes chilled by contact with the relatively cool bricks of the chimney back or if insufficient air is supplied, the yellow flame becomes red and dingy, while particles of finely divided carbon are deposited on the adjacent surfaces or whirled away up the chimney.

The ordinary coal-oil lamp is one of the best illustrations of perfect combustion and consequent smoke prevention. The heated gases rising in the chimney produce a draft, and fresh air is continually drawn in at the bottom through the hot gauze, which warms and divides it so as to insure thorough mixing with the gases from the burning oil. Turn up the wick and the flame becomes smoky—too much hydrocarbon for the air supply. Raise the chimney slightly from the bottom and again there is smoke—too much air at too low a temperature, which chills the flame. Insert a cool metal rod into the chimney and soot is deposited on it—chilling of the flame again and disengagement of the carbon, while the hydrogen continues to burn.

And thus we may learn of the three requisites for good combustion; enough air, a sustained high temperature and a thorough mixing of the gases. The last two are so important that it is entirely possible to have an excessive supply of air and dense black smoke at the same time.

Having thus decided upon the conditions which promote good combustion and prevent smoke, it remains to determine how they may be realized in practise.

It may be said at the outset that it is entirely possible for a good fireman with his shovel, a pile of soft coal and an ordinary flat grate, to so fire a furnace as to make practically no smoke. It may also be said that this is highly improbable and that such a man would command higher wages than are usually paid to firemen.

The best method of hand firing consists in first maintaining as uniform a rate of combustion as possible by putting on coal often and in small quantities; and secondly by varying the air supply to suit any lack of uniformity which may exist. This is known as the one-shovel system of firing and has been successfully used on many of the leading railroads as a means of saving coal and reducing smoke. The nation which shortens its swords lengthens its boundaries and the railroad which shortens its coal-scoops lengthens its mileage per ton. The air supply is usually varied by leaving the door slightly ajar just after coal is put on and then closing it when the coal begins to glow. Several automatic appliances for doing this have been invented and in numerous instances have given good results. The usual plan is to have the device operated by the opening of the fire door at the time of firing.

When the door is opened some simple combination of levers and chains raises the piston of a dash-pot, which in turn lifts a flap in the door itself and opens the valve in a steam-pipe connecting with a system of steam-jets over the door. After the door is closed the flap in the door remains open and so do the steam-jets. The draft created by the latter assists to draw in additional air and the steam mixes it thoroughly with the burning gases. The jets should be directed to the back of the fire near the bridge wall. All this time the plunger of the dash-pot is slowly settling down, dropping the air damper and closing the steam-valve until at the instant when the fresh coal becomes incandescent the air supply is shut off. If the apparatus is made to operate a check-draft in the uptake at the same time the efficiency will be still more improved.

The efficiency of such an arrangement can be clearly represented by diagrams, one showing a cloud of black smoke just as it is cut off by the apparatus being thrown

into gear, while in another are shown the one chimney where the smoke preventer is in use and the three where it is not, about one minute after heavy firing.

The writer has experimented somewhat with air jets maintained by a blower and operated by a dash-pot, but the effect was not so good as when steam-jets were used. When the jets are used intermittently in the manner indicated the waste of steam is small, not over two or three per cent., while the saving in coal is frequently fifteen per cent. Any attempt to solve the problem by admitting a constant additional supply of air through the bridge or side walls has been and will be a failure, since the air supply must be varied as the demand varies.

Hand firing is at best a crude and unsatisfactory method and is gradually being superseded by mechanical means of feeding the coal to the furnace. Mechanical stokers, as they are now called, have two great advantages over hand firing: (1) The uniformity of coal feed which allows a uniformity also in the air supply; and (2) the fact that it is no longer necessary to open the door. Add to these the saving of hand labor and the possibility of handling the coal mechanically from car to furnace, and you have a good argument for the new way.

All mechanical stokers, whether inclined grate, underfeed or chain grate, are intended to feed the coal steadily and uniformly at a speed proportionate to the demand for steam, and by thus maintaining a constant rate of combustion to simplify the problem of air supply. There are at the present time at least ten different makes of stokers which are capable, when properly cared for, of maintaining this uniform combustion in such a way as to prevent smoke and save fuel. Of course somewhat extravagant claims have been made by manufacturers and agents with regard to the economy of these machines. Speaking in a guarded and conservative way, it is safe to say that any of the stokers above referred to can show a saving of from ten to fifteen per cent. over the results of ordinary hand firing.

Perhaps one of the most common causes of smoke is the overcrowding of the boilers. As the amount of work done in a factory gradually increases, new machines are added, more shafting and pulleys purchased, perhaps under pressure from the engineer a new engine is installed. The boiler plant is usually the last to receive attention, although all this time it has been suffering from overload. A boiler gives the best efficiency when worked up to or slightly over its rating; any further crowding will result in smoky fires and waste of fuel. The writer recalls one instance of this kind where an analysis of the ash showed fifty per cent. of free carbon.

Although mechanical stokers will sometimes increase the capacity of boilers, they are liable to overcrowding as well as the flat grate. This results in fires which are too heavy to be successfully handled and in a loss of economy. Overcrowding also increases the repair bill on both furnace and boiler and is on the whole an expensive experiment.

Cleaning fires is another common cause of black smoke, in most cases without excuse. A careful and skilful fireman can keep his fires clean and bright whether on flat grates or mechanical stokers, without any great disturbance of running conditions. Many firemen do not, either because they do not know or because they do not care. The writer has seen a fireman so completely uproot and tear in pieces his fire in cleaning as to necessitate almost a rebuilding. On the other hand, he has seen a skilful man so clean fires on stokers in an efficiency test where the boilers were being crowded to their utmost, that there

was practically no drop in pressure and no perceptible checking of the combustion.

Unskilled and underpaid firemen are responsible for a great deal of the poor economy and the black smoke of our boiler furnaces.

Of the efficiency of mechanical stokers in preventing black smoke there can be no doubt in the mind of any one who has seen them in operation side by side with the old type of hand-fired flat grates.

Their economy can be estimated from the following figures, which are the result not of isolated tests, but of a careful observation covering a period of years. The average rate of evaporation with hand-fired Ohio or Pittsburg bituminous slack is from five to six pounds of water per pound of coal under actual conditions. With mechanical stokers the average rate is from seven to eight pounds of water per pound of coal, and more than this has been obtained under test conditions.

A saving of from 15 to 30 per cent. may be expected from the use of mechanical stokers, and if the cost of steam to run the machine be estimated at 5 per cent. (a liberal allowance) there is left a very comfortable margin.

As the writer is no longer connected with any city government and can not be accused of any warping of judgment, he has no hesitation in saying that he considers the chain grate, as made by the Babcock & Wilcox Co., the Green Engineering Co. and others, as being the most successful solution of the problem of burning soft coal economically and without smoke, so far presented.

The uniform thickness of fire, the steady feed under the boiler and the automatic cleaning are the salient features in an apparatus which is much better than any stoker yet invented.

If one could have a picture of Newburg, that smoky suburb of Cleveland, as it was five years ago, and then again as it is today and as it will be a year from now, when the transition from hand firing to chain grates shall have been entirely completed, there would be no need of any argument on this score.

There is more than one phase in the science of smoke prevention. So far we have considered the strictly mechanical side. There are also the ethical and the legal sides to be considered. Grant that smoke can be prevented, how shall we insure that it will be, without trenching on those rights which every American citizen claims as his? Ethically considered, every one has a right to as much smoke as he wants, so long as he does not incommode or injure his neighbors.

The damage to property and to health from soft-coal smoke is now so generally conceded that no argument on this point is necessary. In other words, the man who allows black smoke to issue from his chimney is guilty of maintaining a nuisance as much as he who allows garbage or foul water to accumulate on his premises.

To quote from the ordinances of the city of Cleveland:

> Sec. 2. That the owner, agent, lessee or occupant of any building or structure of any description from the smoke-stack or chimney of which there shall issue or be emitted such dense or black or gray smoke within the corporate limits of the city of Cleveland, shall be deemed and held to be guilty of creating a public nuisance, and of violating the provisions of this ordinance.

The fact, once established by law and precedent that smoke production is a nuisance and that smoke producers may be fined like other law-breakers, it would seem to be a comparatively easy matter to control the evil. Experience has shown that this is not the case and that very few convictions have been made under the law.

The first step that should be taken to regulate smoke production is to make it

incumbent on the owner or builder of every new establishment, where soft coal is to be burned, to install the proper apparatus for burning it smokelessly. It should be necessary for such owner or builder to obtain a permit for setting boilers or furnaces, contingent on proper compliance with the laws regarding smoke abatement, just as it should be necessary to obtain a permit for erecting a building in compliance with the laws concerning safety against fire and accident. This provision is not a hardship and it inures as much to the benefit of the owner as to that of the public.

If every new furnace is thus set in a proper manner and is under the inspection of the proper officers, a rapid improvement will take place. The old will in the nature of things disappear; it is the new which must be the more carefully watched.

In dealing with establishments where smoke is already in evidence both moral and legal suasion must be employed; the former when it will serve, the latter as a final resort. Once convince a man that coal will be saved when smoke is stopped, and the battle is half won. The writer has a record of scores of such bloodless victories.

Before very much can be said to an offender it is necessary to prove to him that he is an offender, and this can only be done by systematic observation covering some little period of time. Whatever system is adopted, the ratings of the various stacks will depend largely on the judgment of the observer and smoke charts are an unnecessary incumbrance. Readings taken at intervals of three or five minutes for several hours, with a grading from one to four in the scale of blackness, will give a fair relative showing for the various chimneys observed and furnish a basis for arguments with the various proprietors.

An observer who has had experience can rate twenty to thirty chimneys in this way from a convenient vantage point. If 4 is taken as dense black smoke and 0 as absence of smoke, a two-hour series of five-minute readings, or twenty-five in all, will give the percentage directly by summation. These two-hour sets can be repeated at different times of day so as to cover the whole period of daylight. In this way the inspector soon becomes thoroughly familiar with each district and knows all the black sheep. A fair comparison made from such ratings will often shame the offenders into better performance.

In rating locomotives a different method must be adopted, as the time of observation is rarely over two or three minutes. For this work a graphic log has been found most reliable. Heavy horizontal lines represent per cent. of black smoke, while vertical rulings represent time intervals, usually from three to five minutes each. The observer counts regularly as he watches the stack and puts down at each interval of time a dot on one of the horizontal lines corresponding with the smoke at that instant. A line drawn through these dots shows plainly the variation in conditions. The other data are filled in as far as they can be ascertained and a copy of this report (made in duplicate by the use of carbon paper) is sent to the proper official of the road immediately. This makes a record which is rarely disputed by the engineer or fireman.

This system as applied in Cleveland had the immediate effect of reducing the smoke from locomotives to less than half the former amount as a result of improved firing, and there has been steady improvement ever since.

In dealing with the smoke problem where the evil already has a firm foothold it is necessary to institute at first an educational campaign, showing the conditions as they exist, the possibility of betterment and the resulting economy. Most smoke-producers are intelligent and reasonable men and will

listen to such arguments and will endeavor to effect improvements.

When such methods fail and the parties interested are obdurate, legal methods should be used. The law or ordinance must be carefully drawn and subjected to the best legal criticism before it is tried. 'It is better never to have sued than to have sued and lost.' But if the ordinance does fail, one has profited by experience and the next ordinance will be stronger.

To sum up the facts and conditions as they have been outlined in this paper it may be said:

(1) That objectionable smoke from soft coal can readily be prevented; (2) that such prevention will result in a higher efficiency and smaller fuel bills; (3) that all new plants should be subject to permits issued by proper city officials; (4) that educational and legal measures combined should be used in cases where the evil already exists; (5) that the control of such work should be in the hands of properly trained engineers who understand the whole subject thoroughly; (6) that the people of each community must see to it that they are protected from this evil as from poor drainage and dirty streets.

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December 15, 1903.

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*THE CARDINAL PRINCIPLES OF ECOLOGY.**

WITHIN recent years that old phase of natural history which is concerned with the adaptations of organisms to their environment has become segregated into a distinct department of study under the name of ecology (œcology, biologie). This separation is unnatural, but it is expedient, and it is likely to result in great advances towards that most important, difficult and alluring of scientific ends, the explanation of the raisons d'etre in organic nature.

As now studied by botanists, ecology is concerned mostly with that synthetic phase of the subject dealing with the interpretation of the physiognomy of vegetation, while comparatively little is being done in the analytic phases which investigate particular features, or elements, of adaptation. To such an extent is this the case, in this country at least, that we are accustomed to use the word 'ecology' as a synonym for 'ecology of the vegetation' or 'ecological plant-geography,' a somewhat misleading usage which has been, with some justice, censured. Criticism of the use of the name, however, is of slight account in comparison with the current criticism, unpublished but wide-spread, of the methods of the subject as followed among us. Such criticism arises in part from that ubiquitous human failing which leads us to exalt our own lines of work by invidious reflections upon other lines which we do not, or will not, understand; but it is in large part deserved. Ecological publications in America are too often characterized by a vast prolixity in comparison with their real additions to knowledge, by a pretentiousness of statement and terminology unjustified by their real merits, and by a weakness of logic deserving the disrespect they receive. The subject suffers, I fear, from a phase of the 'get-rich-quick' spirit. These opinions I can express with the better grace when I hasten to admit that, so far as my own few publications are concerned, I am one of the chief of sinners. I believe it is a fact that, despite our numerous ecological publications, the only material advances made in ecology in this country for some years past are in descriptions of vegetation, in which a considerable body of fact has been accumulated. But in interpretation, the very soul of ecology, we have done little

* Read before the Society for Plant Morphology and Physiology at its Philadelphia meeting, December 29, 1903.

else than continue to kaleidoscope the old and familiar matter. Yet the aim of ecology is perfectly definite, and as lofty as any in science, being nothing less than to explain why each plant is what it is, where it is and in the company it is. Why then do we fall so far behind our ideal? The reason is perfectly plain. We have reached, and long since, the point at which, with our purely observational methods, the law of diminishing return applies strongly to the investigation of the subject; and further substantial advance is now possible only through the aid of some new method. Further, the nature of this new method is equally plain, and it is only practical limitations of time and cost which keep us from utilizing it. It lies in the precise experimental study of the physics of the environment, and of the physiological life histories of particular plants, with the invention of a mode of recording the results in a form to permit the one to be correlated with the other. There must go along with this an improvement in our ecological reasoning; or rather, to be correct, real reasoning, involving logical proof, must be substituted for those speculative yokings of conspicuous effects with prominent possible causes which too often take the place of reasoning in our ecological works.

For this indispensable dual study of environmental physics and adaptational physiology we have some, though no great, foundation. Our knowledge of the physics of the atmosphere and our methods for investigating it are, thanks to meteorology, fairly satisfactory, but we need a new form of record for meteorological data which will make them more directly available than at present in the interpretation of ecological phenomena. Our knowledge of the physics of the soil, however, involving factors more important in the aggregate than those of the atmosphere, is comparatively scanty, while methods for its exact study are only beginning to be developed. The exact study of soil physics (using this term broadly) seems to me the greatest present single need of ecology. Turning to the other member of the ecological equation, the plant, whose physiological powers and limitations determine its adjustment to particular environments, it appears to be a fact that no attempt has yet been made to apply our considerable physiological knowledge, and our excellent physiological methods, to the elucidation of the physiological life-history of any one of even the important forms constituting our vegetation. Yet it is only through such studies, for which some new appliances and methods must be developed, that we can hope to understand not only the factors involved in the adaptations of the particular form to its environment, but also the nature of the all-important subject of plant-competition, which determines how the forms build up a vegetation. No doubt the subject will ultimately work itself out as a series of ecological life histories, in which the physiological powers and limitations of each plant will be expressed in a system of standard units or formulæ with all the definiteness of the taxonomic terminology of the present day. But such studies as these can not be made by busy teachers who can give to them only a vacation leisure and a scanty equipment. They can be made only by trained investigators who, with ample time, expert assistance, and properly equipped field laboratories, can give themselves wholly to it. Into this fruitful field we welcome the Carnegie Desert Laboratory; may its kind increase until we have not only mountain, jungle, seaside and forest laboratories, but also another form which can be moved from place to place in pursuit of the most pressing problems.

Such seems to me the status of plant ecology at present and the direction it must

take for the future. I propose to discuss now very briefly the principles which appear to me to be fundamental to a right understanding of the nature of ecology.

Principle 1. The Reality of Adaptation.—To a first view it seems logically possible that adaptation may have only a subjective existence, and that the cases we consider adaptations may be merely accidental correspondences between certain features of the organism and certain characteristics of the environment, involving no real advantage to the organism. Now there can be no doubt that many cases commonly reckoned as adaptations are of this imaginary nature (it could hardly be otherwise while *post hoc propter hoc* is the prevailing type of ecological reasoning), but that some of our adaptations have an objective existence is susceptible of direct proof. Thus the mechanisms connected with cross-pollination in specialized orchids represent a typical adaptation. If, without other injury to the plant, these mechanisms are prevented from operating, no seed is formed and the result is disastrous to that race of plants. Hence the advantage of the mechanism is made manifest, and the reality of the adaptation is proved.

This case illustrates the fundamental idea, and permits a definition, of adaptation. It is an adjustment between some feature of an organism and some characteristic of its environment such that the organism functions better than it could did such an adjustment not exist.

Principle 2. The Evolutionary Phylogeny of Adaptation.—Logically two views are possible as to the phylogeny of a real adaptation. (1) It may have developed quite independently of any connection with the environment it now fits and have come into its present relation with that environment by a sort of sifting process permitted by the constant movement or circulation of organisms in nature, very much as a number of vari-shaped blocks shaken in a box having vari-shaped cells opening from it would each come finally to fill the cell with which it most nearly corresponds in shape. (2) It may have arisen gradually, either by innumerable fine gradations or by somewhat marked steps, in close touch with the environment, which may be acting either directly causatively or only selectively. The former view has received its strongest advocacy in the recent book by Morgan, while the latter is that almost universally prevailing, and, as I believe, correctly. There is no doubt that some adaptation is of the former sort; and in some phases of ecology, notably in distributional phenomena of ecological plant geography, it plays an important rôle. But that adaptation is usually and essentially of this character seems to me wholly denied by the evidence. There is not, so far as I know, any form of proof that can be adduced to decide between these two possibilities, but there is an argument from probability so strong as to be practically conclusive. It lies in the cooperation of many distinct features of adaptation to fit a form to a very special or unusual environment requiring simultaneous and different kinds of modification in many parts. Thus, to take the case of epiphytes (such as the tropical epiphytic ferns), if these were adapted in but one feature alone, such as the roots, it would be logically quite possible that this kind of root had arisen by some method independent of contact with the environment, and that this form having been brought accidentally into this habitat persists there because these roots fit that environment better than any other. But the probability that this adaptation of the roots has arisen independently of the environment is greatly weakened when we note that so different a structure as the leaves are also, and equally well but in a different way, adapted to this habitat. And when, further, we observe

that adaptations equally good but of a different kind are found in the stems, in the tissue systems, in several phases of irritability and in other features all involving considerable changes from the ancestral forms, then the chances that all of these adaptations, involving most or all of the external structures of the plant, could have arisen without regard to the environment become so small as practically to disappear. On the other hand, the development of adaptations in causative touch with the environment, by whatsoever method the modification may be brought about, gives a perfect explanation of such cases of concomitant adaptations as are here in consideration.*

Adaptation, as the probabilities overwhelmingly indicate, usually develops in touch with the environment. But from the point of view of the ecologist the method of evolution, whether by selection of fluctuating variations, by inheritance of individually acquired characters, by mutations or by some other method yet unknown, is a matter of only incidental and not of essential interest. On the other hand, it is altogether likely that adaptation, properly studied, will throw light upon the method of evolution, for it is probably true that adaptation has been in some measure the guide of evolution; or, to express the subject in another way, adaptation seems to bear to evolution a relation somewhat analogous to the relation of a stimulus to its irritable response.

Principle 3. Adaptation a Race, not an Individual, Process.—Many phenomena in organic nature point to a distinction between the race and the individuals which compose it. The distinction is not metaphysical but physical, though its precise physical basis is uncertain, the race having its basis in the protoplasm, or the part of it, bearing the characters common to all the individuals, and the individual having its basis in its share of the race protoplasm plus the differences which are its own alone. Now as to the relation of adaptation to race *vs.* individual, two views are possible, aside from any theories: (*a*) adaptation originates and develops in the individuals, and then, by a method unknown, becomes fixed in the race (a corollary of which is that the individuals are the leading or important element in organic nature, the race being secondary); and (*b*) adaptation is primarily a race matter, finding its visible expression in the individuals (a corollary of which is that the race is the leading and important element, the individuals being secondary to it). The former is the popular conception and that of some students, but the available evidence seems to point overwhelmingly to the correctness of the second. The phenomena exhibited by the social insects among animals, the regular transmission of both sexes through one sex, and the phenomena of reproduction generally can only be explained on the basis of race adaptation being dominant over individual

* These cooperations of many adaptations fitting a form to a particular habitat, involving changes in many features simultaneously, seem to me to offer one of the very greatest difficulties to the selection theory of the development of adaptations. On the hypothesis of selection of fluctuating variations, favorable variations in one feature bear no relation to favorable variations in another, except in rare cases of correlation. When, therefore, selection is preserving the individuals favorably varying in one character, it is surely preserving unfavorable variations in some other characters. Selection, it would seem, could only produce adaptive modifications in one or a very few characters at a time, and hence simultaneous modifications in many distinct characters, such as actually appear to have occurred in such cases as epiphytes, would not be possible. The mutation theory offers even greater difficulties. The Lamarckian (Neo-Lamarckian) theory, on the other hand, admits of indefinitely numerous concomitant or simultaneous adaptations, though this theory has its difficulties from other points of view.

adaptation. The distinction often made between adaptations for the good of the individual, such as irritable responses to stimuli, and these for the good of the race, such as various reproductive processes, is merely a matter of convenience without logical basis, for not only is the line between the two extremely indefinite, but also it is evidently as necessary for the good of the race to preserve the reproducing individuals as to secure their reproduction. Adaptation may apparently all be reduced to a race basis, only that being individual which is connected with individual variability. The relation of the race to the individual appears to resemble somewhat the relation of the mortality tables to the individual human life; or the race is like a mighty moving current, while the individuals are the ripples that play upon its surface or the eddies that swirl in its depths. In practice, therefore, adaptation is to be studied from the point of view of its advantage to the race under consideration rather than from the point of view of its individuals; and, further, conclusions can not safely be drawn from individual cases, but must be based upon studies of the race, which can be accomplished best through the use of statistical methods. A corollary of this principle is this, that the meaning of adaptation is to be sought deep in the activities of protoplasm rather than in the superficial manifestations of structure. Structure is but the external manifestation of protoplasmic activity, the tool, as it were, by the aid of which the protoplasm more perfectly accomplishes its work.

Principle 4. Metamorphic Origin of Adaptation.—In such cases as I can recall, in which the phylogeny of an adaptive feature is known with reasonable certainty, it seems to be the case that the new adaptation has not arisen *de novo* out of the plant substance, but through the metamorphosis of some preexistent feature, itself formerly adaptive. It seems to me logically a probability that adaptations frequently, if not generally, have their origins in the metamorphoses of preexisting adaptations, and *omnis adaptatio e adaptatione* may yet become a postulate of ecology. The origin of a new adaptation, upon this principle, would be somewhat after this manner. When changing environmental conditions, or the opening of a new field, bring about a need for a new adaptation, both change and need arising very gradually, this need can be met, and a new adaptation can arise, only in case there is available in the plant some existent feature which happens to be capable of filling that need in its earliest stages, and of being modified to fill it better, either by selection of its fluctuating variations or mutations, or by more direct method, as the need becomes more intense. In such a case, when the full intensity of the need has been reached, the modification or metamorphosis of the original feature will have gone so far that we recognize a new adaptation. If, however, no feature capable of filling the need in its earlier stages exists, or if the need arises too suddenly, then there is no adaptation, the organism can not meet the new conditions confronting it, and it must either keep to its old mode of life, or, if that be impossible, become extinct. Such a principle gives a logical explanation of the remarkable irregularity of distribution of adaptation at the present day, and removes much of the difficulty as to the origin of new adaptations. In discussing the origin of adaptation we too often forget, not only that the need for new adaptations must arise as a rule very gradually, but also that the modifying agency, whatever that may be, makes its effects felt very gradually; or, as it may be expressed, the plant is passed from under the action of one adapting agency to the action of another not

suddenly but gradually. It certainly seems as logical that both adaptations and adaptive agencies should show continuity as that organisms should; and we should be able to trace adaptations back, precisely as we trace organisms, through simpler and simpler conditions until we reach the ultimate origin of them all in the simple undifferentiated protoplasm of the original organisms.

Principle 5. Inevitable Imperfection of all Adaptation.—It appears to be true that no feature of any organism is free to respond unhampered to the influence of an agency producing adaptation. Inevitable impediments to such complete responses arise from several sources—from various hereditary influences, from physical and chemical limitations of their powers, from the necessity of providing for nutrition, support and protection, from the presence of other adaptations, and from the presence also, it is possible, of other features highly developed without reference to any utility. The result of the operation of all of these influences upon any feature is a state of equilibrium, of which adaptation is a part, no doubt usually as large a part as the other conditions will permit, but frequently only a minor part. In every case, therefore, adaptation must fall below its perfect development, or must be imperfect. Of no feature can it be true that it is all adaptation, but it must be adaptation plus other considerations, and the latter in any structure may collectively even outweigh the former. Now it is without doubt the task of the ecologist not only to determine adaptation, but as well to delimit the other influences which interoperate with it to make structures what they are. In other words, it is the task of the ecologist to determine the meaning of the features of the plant whether that meaning involves adaptation or not.

Such seems to me the nature of adaptation as indicated by the evidence we possess. Certainly it is true that ecology is but in its beginning.

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SCIENTIFIC BOOKS.

Palmer's 'Index Generum Mammalium.'*

Dr. Palmer's 'Index Generum Mammalium' is a work of immense labor, painstakingly and intelligently performed, and its publication will form a landmark in the history of mammalian nomenclature. It furnishes not only an elaborately annotated list of all the generic and family names of mammals, recent and extinct, published since the beginning of the binomial system of Linnæus down to the end of the year 1903, but the introduction, besides disclosing the origin, history and scope of the work, furnishes a fund of historic information that should most favorably influence the methods of the future in the bestowal and use of names by systematists, not only in mammalogy but in other departments of natural history.

The work consists of an 'introduction' of about 70 pages, followed by Parts I.–III., with an appendix, and an index to Part III. Part I. comprises 'Index of Genera and Subgenera' (pp. 71–717); Part II., includes the 'Family and Subfamily Names of Mammals' (pp. 719–776); while Part III. is an 'Index of Genera Arranged According to Orders and Families' (pp. 777–948). The appendix contains names discovered too late to insert in their proper places in Part I. and various additions and corrections, by means of which 'the index is brought down to January 1, 1904.'

In the 'introduction' (pp. 8–69) there is first a statement of the history and purpose of the work. From this it appears that the work was begun by Dr. C. Hart Merriam about

* 'Index Generum Mammalium: A List of the Genera and Families of Mammals.' By T. S. Palmer, Assistant, Biological Survey. Prepared under the direction of Dr. C. Hart Merriam, Chief of Division of Biological Survey. North America Fauna No. 23, U. S. Department of Agriculture, Division of Biological Survey. Washington, Government Printing Office, 1904. (January 23, 1904.) 8vo, pp. 984.

1884, and was taken in hand by Dr. Palmer in 1889, who continued it, aided by competent assistants, till its completion in 1903, it being carried on in connection with the systematic work on mammals conducted by the Biological Survey. Under 'acknowledgments' special mention is made of the careful and painstaking work of Miss Thora Steineger, who spent much time in several of the leading libraries of Europe in verifying references, besides rendering important clerical assistance in Washington throughout the progress of the work. Especial thanks, on behalf of the users of the index as well as the author, are also rendered to Mr. F. H. Waterhouse, librarian of the Zoological Society of London, who, on learning of Dr. Palmer's work, generously placed in his hands a large amount of manuscript he had already prepared for a similar undertaking.

The introduction treats in much detail all the principal questions, moot and otherwise, that relate to nomenclatural usage. Under 'References and Dates' is considered the important question of what constitutes publication, and the necessity of determining, and respecting, actual dates of publication, which are often difficult to ascertain. In this connection is presented a useful list of special papers giving dates of publication for works issued in parts, and dates of the parts of the 'Proceedings' of a number of scientific societies and museums. Under 'Authorities and Localities,' and 'Types and their Determination,' are treated important questions of usage about which authorities often differ, as the determination of types of genera, etc., apropos of the author's methods in the present work. A list of 'Hypothetical Genera' is accompanied by pertinent comment; 'Changes in Form of Names' covers a consideration of the much-vexed question of the proper treatment of 'emended' names. On this point the author says: "Probably no section of the A. O. U. Code has been the subject of so much criticism as Canon XL., which provides that 'the original orthography of a name is to be rigidly preserved, unless a typographical error is evident.' Stability and priority are two of the cardinal principles of the code, but priority is merely a means of securing stability, and applies as well to the adoption of the earliest name as to the earliest form of that name. Experience has shown that any other course leaves the door wide open to emendation and resultant confusion." A number of generic names are cited, having from five to eight variants that have been more or less in use, in illustration of the results of emendation; and in further elucidation of the extent to which emendation may be carried, it is shown that the name *Aplodontia,* with eight actual variants, 'is capable of at least twenty-four modifications, each one differing from the rest by a single letter.' Some eminent zoologists maintain that a difference of a single letter in two names is sufficient to distinguish them, and to prevent the later name or names (for there are often several) from being thrown out as preoccupied, whether the difference in form is due to gender, to a difference in the connecting vowel in compound words, or to the presence or absence of aspirates; while others consider names the same when having the same etymological origin, though differing in form.

Under 'Rejection of Names' the author considers at length the following topics: 'Preoccupied names,' under which is given a most useful 'List of Homonyms within the Class Mammalia; and another list of preoccupied names in mammalogy and ornithology; 'nomina nuda,' French common names of Latin derivation, 'plural subgeneric names,' etc.

Pages 41–46 are devoted to the 'Etymology of Names,' under which are considered classical names, barbarous names, 'nonsense names' ('coined' names and anagrams), mythological names, geographical names, personal names, compounds and double generic names. These pages contain an immense amount of information, both historic and etymological, in reference to the sources and relative prevalence of these different classes of names, illustrated by tabular expositions, which are not only of high interest but of much practical utility, but which it is impossible here to particularize. The section devoted to 'Application of Names' (pp. 60–

67) also abounds in interesting and practical information.

In Part I., 'Index of Genera and Subgenera,' the names stand in alphabetic sequence, and under each are given from half a dozen to a dozen distinct and important items of information, as follows: Author and date; the order and family to which it is referred; the place of its original publication; its variants, if any, and by whom, when and where published; its type if specified, and if no type was given by the author, and none has been since 'fixed,' a list of the species originally included under it; the locality whence, and the place where the type was described, and, if an extinct species, the character of the type specimen, and its geological formation and locality; its etymology and significance, or, in the case of a barbarous name, its original source and use. If the name be antedated or preoccupied, these facts are duly noted; and where the same name has been proposed for different genera of mammals, its several uses are given chronologically. In this way the history and status of each name is fully set forth, so that its availability or non-availability is easily determined. In no other work has such fulness of treatment been given, nor is it easy to see where anything essential to the history of a name has been omitted. As the 'index' includes upward of 4,500 names, the immense amount of labor involved in its preparation is evident, while no similar work is to be compared with it in fulness of detail and consequent usefulness. Of these 4,500 names, it is stated that over 400, or 10 per cent., prove to be preoccupied, and of these latter 'about 150, or nearly 40 per cent., are homonyms in the class Mammalia' (p. 953).

In Part II., 'Family and Subfamily Names,' the treatment is necessarily different, in accordance with the requirements of the case. Here the name, author, date and the order to which it is referred are stated, followed by a reference to the place of first use, with secondary references to its variants, if any, and modified uses as regards the rank of the group. The arrangement is, of course, alphabetic, and the index proper is preceded by several pages giving the history of the origin and use of such names, particularly in reference to the final adoption of the terminations *idæ* and *inæ*, indicating respectively families and subfamilies. There is also a summary of the rules that have been proposed by different nomenclatural codes in relation to these groups, and illustrations of the difficulty of applying these rules.

Part III., 'Index of Genera Arranged According to Orders and Families,' has been prepared to show 'what names have been used in a certain group, why a name is unavailable, or whether any published name is available for one which is preoccupied.' The arrangement is here alphabetic, first as regards orders, and secondly as respects the families, subfamilies and genera, within the orders. The classification adopted is that of Flower and Lydekker in 'Mammals, Living and Extinct' (1891), with modifications; the nomenclature, however, is often different. 'The name of the class Mammalia,' says the author, 'is one of the few names concerning which there is universal agreement.' After illustrating how modern authorities differ in respect to the names of even the primary divisions of the class, the author gives an outline of the classification and nomenclature here adopted, and an explanation of his system of cross references designed to facilitate the finding of any desired name.

This part of the work is especially important, and amounts to, practically, a revision of the nomenclature of the Mammalia, recent and extinct. In respect to family names, the name based on the earliest generic name has been adopted when available, as when the genus on which it is based is not antedated or preoccupied. Under the family name are cited (1) its synonyms and subfamilies, (2) its genera, with the author, date and type species of each. Recent genera are distinguished from extinct genera by the use of black-faced type for the former and italic for the latter; preoccupied names have a dagger (†) prefixed, but names otherwise untenable appear not to be designated, except as shown by the context.

The appendix adds 35 names discovered too late to be included in Part I. These include

a few from Frisch (1775) and a considerable number from Billberg (1828), and others proposed during 1903. These early names are fortunately merely *nomina nuda,* or synonyms, or otherwise untenable. The appendix also includes several pages of corrections, some of them important, affecting the authorities for a few genera given in Part I., and in one case the orthography of a name, *Tayassu* G. Fischer (1814) becoming *Tagassu* Frisch (1775), with a corresponding change in the family name based on this genus.

It can not be supposed that a work of this character can be entirely free of errors, but with the great care taken in the preparation of the manuscript (see p. 11) they are doubtless reduced as nearly to a minimum as can reasonably be expected. The work embodies the results of a vast amount of labor, for which mammalogists can not be too grateful; it has set a high standard for future workers in the same line to emulate; and has placed in the hands of experts in nomenclature an invaluable aid in their work. J. A. A.

Monograph of the Coccidæ of the British Isles. By ROBERT NEWSTEAD. Vol. 2. London, Ray Society, 1903. Pp. 270; 41 plates.

The long-expected second volume of Mr. Newstead's monograph is at last to hand, and we have in the completed work the best treatise on the Coccidæ yet published. The beautiful colored plates, the excellent notes on habits and modes of occurrence and other good features maintain the high standard set in the first volume; and as before, many of the species are as familiar in America as they are in England.

The nomenclature employed is in most cases very different from that of Mrs. Fernald's new catalogue, although the more recent views are discussed in an appendix. Mrs. Fernald's catalogue had not appeared when Mr. Newstead's volume went to press, which is to be regretted, as it contains much bibliographical matter which would have been of service to the author. In the present state of coccidology any writer may well be excused for not accepting all the recently proposed innovations; but it does seem to me that some of them stand on unassailable ground, and should not be resisted by any logically minded person. For example, *Pseudococcus* can not be allowed to stand for species, none of which were placed therein by the describer of the genus.

As regards both genera and species, Mr. Newstead is a 'lumper,' though by no means a reckless one. I have been studying his excellent descriptions and figures, and find that, according to the system represented by Mrs. Fernald's catalogue, the following changes (among others) should be made:

Lecanopsis formicarum, Newst., becomes *Spermococcus formicarum.*

Dactylopius pulverarius, Newst., becomes *Trionymus pulverarius.*

Ripersia terrestris, Newst., becomes *Rhizæcus terrestris.*

Ripersia halophila (Hardy) becomes *Ripersiella halophila.*

Thus four genera are added to the British fauna; the third, however, evidently introduced by man. The indication of these generic relationships, whatever may be thought of the genera, is strongly suggestive of certain specific resemblances. It is not improbable that future careful comparisons will bring to light some synonymy.

If, as Mr. Newstead holds, all the British forms of *Phenacoccus* (he calls them *Pseudococcus*) are of one species, the conclusion seems almost irresistible that *Phenacoccus pruni* (*Coccus pruni,* Burm., 1849) is its proper name. According to Mr. Newstead's figures, the second antennal joint, while usually considerably longer than the third, varies to about equal with it. Among our American species, these joints also vary, but we have recognized what appear to be three different types, not normally intergrading:

1. Second and third joints nearly equal. *P. dearnessi, rubivorus, minimus, spiniferus, acericola.*

2. Second conspicuously longer than third. *P. solenopsis, helianthi, wilmattæ, artemisiæ, cevalliæ.*

3. Third conspicuously longer than second. *P. osborni, simplex, stachyos.*

These species of course have other peculiarities, but I certainly have believed that the

antennal characters (allowing a good deal of variation) were specific. Of course, it is quite possible that the English insect is more variable than the American ones, as is true of certain English plant genera, *e. g., Rubus* and *Hieracium.*

One of the best tests in all such cases is the transplanting of specimens to different food-plants. Mr. Newstead did this rather extensively in the case of *Pulvinaria ribesiæ,* which he treats as a variety of *P. vitis.* It was found that the *P. ribesiæ* could not live on certain plants which are normally infested by *P. vitis,* and this, I think, should make one hesitate to assume the identity of closely similar forms.

Dactylopus walkeri, Newst., is evidently the British representative of our *D. neomexicanus,* the antennæ and other characters being very similar. In the figure accompanying Newstead's original account of *D. walkeri* the last antennal joint was apparently made too short.

It is strange that no mention whatever is made of *Lecanium liriodendri,* which was described from English specimens.

T. D. A. Cockerell.

SCIENTIFIC JOURNALS AND ARTICLES.

The Popular Science Monthly for March opens with an article on 'Aerial Navigation,' by O. Chanute, which gives a résumé of what has been accomplished up to the present. W. LeConte Stevens discusses 'The Metric System: Shall it be Compulsory?' intimating that it must not be. J. Madison Taylor has a second paper on 'The Conservation of Energy in Those of Advancing Years' and Edward F. Williams has the first of a series of articles on 'The Royal Prussian Academy of Science, Berlin.' N. L. Britton describes 'The Tropical Station at Cinchona, Jamaica,' and Edw. D. Jones discusses 'Education and Industry,' noting the changes that have taken place in training for commercial life. O. F. Cook presents a paper on 'Evolution Not the Origin of Species,' holding that while evolution may change the character of species it does not originate them, this being due to vital motion. Lafayette B. Mendel gives 'Some Historical Aspects of Vegetarianism' and Naohidé Yatsu gives a sketch of 'Tokyo Teikoku Diagaku (Imperial University of Japan).'

The Museums Journal of Great Britain for February contains an article on 'The Museum Question in Europe and America,' by Ant. Fritsch, in which the author notes that many undesirable features are to be found in museum buildings through the undue influence of architects. It is noted that most exhibition collections are too large and a plea is made to have them of smaller size and greater educational value. Alex. M. Rodger describes 'A Method of Mounting Fish with Natural Surroundings,' large, rectangular tanks being employed and the fish preserved in formalin. A meeting is noticed to consider 'The Organization of British Zoologists' and the balance of the number is filled with reviews and notes.

We learn from the *Journal of the American Medical Association* that Dr. K. Kjellberg, of Stockholm, has commenced the publication of a weekly medical journal, to be the official organ for the General Swedish Medical Association. The title is *Almänna Svenska Läkartidningen.* The first two numbers contain instructive articles on 'Arrhenius and the Doctrine of Immunity' and others on Finsen treatment of lupus, paraffin prothesis, etc. The list of collaborators on the journal includes Professor E. Almqvist, J. Borelius, H. Köster and seventeen others. The journal *Eira* was previously the organ of this association, but it suspended publication on the death of its editor, Dr. Simon, last June.

SOCIETIES AND ACADEMIES.

GEOLOGICAL SOCIETY, WASHINGTON.

The one hundred and fiftieth meeting of the society was held January 27.

Mr. Wm. H. Dall read a paper on 'The Miocene of Maryland and its Relations,' in which the relations of the Chesapeake Miocene of Maryland to that of Virginia, North Carolina, Florida and the Miocene of central and northern Europe were elucidated and discussed. This paper will form a chapter in the forthcoming report on the Miocene of Maryland,

in the publications of the Geological Survey of that state.

Mr. Ralph Arnold then presented a paper on the 'Faunal Relations of the Carrizo Creek Beds of California.' He first described the physiographic features of the Carrizo Creek country, which lies in San Diego County on the edge of the Colorado Desert near the Mexican boundary line. The faunal relations of the mollusks of the formation were next discussed. The molluscan fauna indicates that the Carrizo Creek beds are for the most part of Miocene age, that they were laid down in comparatively shallow water, and that their fauna bears little relation to other known California Miocene, but is intimately related to the recent fauna of the Gulf of California. These facts point to the conclusion that during at least a part of the Miocene period the Carrizo Creek country was occupied by a tropical shallow sea or gulf, an extension of what is now the Gulf of California; and that this gulf was separated from the cold waters of the main California Miocene sea by a peninsula similar in position to the present peninsula of Lower California. In other words, he concluded that the major physiographic features in the peninsular and gulf region of Lower California were approximately the same in Miocene times as they are at present.

This was followed by a paper by Mr. T. Wayland Vaughan, entitled 'A Californian Tertiary Coral Reef and its Bearing on American Recent Coral Faunas.' The coral reef, concerning which he spoke, occurs in San Diego, County, California, the locality being the same as that of the Carrizo Creek beds described in the preceding paper by Dr. Arnold. Mr. Vaughan first called attention to the striking difference between the recent coral faunas on the Atlantic and Pacific sides of subtropical America.

In the collection that has so far been made from the California fossil reef five genera are represented, all of which occur in the fossil and recent faunas of the Antilles and not one of which is at present known to occur on the Pacific coast. The age of the beds in which these fossils occur has been determined by Drs. Arnold and Dall to be Lower Miocene. The following conclusions seem warranted: (1) There was water communication between the Atlantic and Pacific across Central America not much previous to the Upper Oligocene or Lower Miocene, that is, during the Upper Eocene or Lower Oligocene. This conclusion is the same as that reached by Messrs. Hill and Dall, theirs, however, being based upon a study of the fossil mollusks. (2) During Lower Miocene time the West Indian type of coral fauna extended westward into the Pacific and it was subsequent to that time that the Pacific and Atlantic faunas have become so markedly differentiated.

ALFRED H. BROOKS,
Secretary.

NEW YORK ACADEMY OF SCIENCES.
SECTION OF BIOLOGY.

AT the February meeting the following papers were presented:

A New Gigantic Tortoise from the Miocene of Colorado: O. P. HAY.

This tortoise was discovered during the year 1901 by Mr. Barnum Brown, of the American Museum of Natural History, in the Pawnee beds of the Miocene, in the northeastern part of Colorado. The remains consist of the shell complete; the skull, lacking the lower jaw; the pelvis and hind limbs; the terminal portion of the tail; and portions of the dermal armor. These materials were exhibited before the academy.

The length of the carapace is about 31 inches. It is high and tumid, with the sides at the bridge perpendicular, and with the hinder border little flaring. The outline is truncated in front, broadly rounded behind, and only slightly repand. The free edges are acute. The bridge peripherals rise somewhat above the middle of the height of the shell, their length transversely to the animal being nearly equal to that of the costal plates. The nuchal scute is narrow; the vertebral scutes not so wide as the costal scutes. The anterior lip of the plastron is broad, rounded in front, and slightly notched in the midline. The posterior lobe has a broad, shallow notch. The pectoral scutes are extremely narrow.

The skull has the palate deeply excavated. The masticatory surface on each side is traversed by a prominent, sharp and dentated ridge. The oral surface of the premaxillaries is excavated for the reception of the tip of the lower jaw. The cutting border of the maxilla is coarsely dentated.

The exposed portions of the hinder limbs, and probably of the fore limbs also, were protected by an armor of dermal bones, as in some living species of the genus. The extremity of the tail is expanded and covered on the upper surface by a plate composed of several bones joined by sutures. The skin of the region around the tail was provided with many pebble-like dermal bones. On the hinder part of each thigh there was a large bony spur. All these bones were covered in life with a thick layer of horn. This new species is named *Testudo osborniana,* in recognition of the interest of Professor H. F. Osborn in the fossil testudines.

Remarks were made by the author of the paper on the geographical and geological distribution of the genus *Testudo* and its related genera, and on their probable origin.

The Flora of Dominica: F. E. Lloyd.

This paper gave a general account of the vegetation of the Island of Dominica, which the author visited during last summer.

The island is of volcanic origin, remarkably broken in contour, and very difficult for travel. The rainfall is excessive, but with considerable differences in distribution. For example, on the west coast there is a mean annual rainfall of 59.51 inches, while 239.50 inches were reported for Middleham in 1901, an amount not far from the mean. The eastern slopes of the island are exposed to the trade winds, and the vegetation, from the shore line to the top of the mountains, shows the effects in the peculiar molding. The temperatures are not excessive, but the atmospheric humidity is great.

The vegetation, excepting in certain restricted areas, is of the tropical rain-forest type. The large trees are clothed with a heavy epiphytic growth chiefly composed of bromeliads, aroids, orchids, ferns and a *Cyclanthera.* At the higher levels the Hymenophyllaceæ, Musci and Hepaticæ predominate, among which, however, many larger ferns and small orchids find a place. Four species of tree ferns, and several species of palms are to be found. *Heliconia,* a plantain-like plant, is very abundant at high altitudes. Lianas and 'ropes,' as air roots are called locally, are abundant.

In the Grand Savannah desert conditions prevail, caused by the small rainfall (59 inches) and the shallow soil underlaid by trap rock. The vegetation here, and along the rocky shore, is quite distinct in character. A viviparous agave and four cacti are here to be found. The savannah is a sloping grassy plain with scattered shrubs and small trees among which occur several Mimosoideæ.

The strand vegetation on account of the steep, gravelly character of the shore is meager in species. The sea-grape (*Coccolobis uvifera*) is everywhere, and *Ipomæa pes-capræ* and *Canavalia* are common. *Terminalia* occurs in some localities.

M. A. Bigelow,
Secretary.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

The academy now meets in its own building, at 3817 Olive St., and held its regular meeting on February 15.

Rev. Martin S. Brennan delivered a popular lecture on the 'Nebular Hypothesis' according to La Place, illustrated with lantern slides. In the discussion following, Mr. Nipher remarked that he had applied the equations for gaseous nebulæ, which had been deduced in his paper on the 'Law of Contraction of Gaseous Nebulæ,' to the case of our own planetary system.

Introducing an integration constant into the pressure formula, the pressure and, as a consequence, the temperature, can be made zero at any radius from the center. He had given the constant a value which made the mass of the nebula equal to that of the entire solar system. When the nebula has reached such a stage that the mass external to Neptune's present orbit is equal to Neptune's mass, the density at Neptune's orbit will be 1.93×10^{-15} grams per c.c., and the pressure will be 1.49×10^{-10} atmospheres. The

outer limit of the nebula will be about half a million miles further out, the temperature being zero at the outer limit. This means that molecular motion will not there exist. The forces there acting will be gravitation and the repelling action of light waves from the central nucleus.

The entire mass of Neptune will exist in a space far more highly rarefied than any Crookes tube vacuum.

It is, of course, possible for such nebulæ to exist, but it certainly is impossible to believe that such a nebula can throw off a system of planetary bodies. The greater part of our solar nebula must have existed as solid meteoric matter, with a temperature approaching alsolute zero. Only the central part, which is now represented by the sun, was largely gaseous, and at a higher temperature.

DISCUSSION AND CORRESPONDENCE.

INSTABILITY OF THE WATER SUPPLY OF THE RIO GRANDE.

TO THE EDITOR OF SCIENCE: In 1540 when Coronado's men were exploring on the Rio Grande, they reported arriving eighty leagues below Tiguex at a place where the river vanished into the ground. Some Amerinds of the region told them it reappeared again much larger farther down. This they did not verify.

As their report of this disappearance, I believe, has usually been ascribed to 'Spanish exaggeration,' it is interesting, as well as important, to place beside it Humboldt's mention, in his 'Political Essay on New Spain,' p. 213 (English translation by John Black), of a similar phenomenon, which took place in 1752.

> The whole bed of the river became dry all of a sudden for more than 30 leagues above and 20 leagues below the Passo, and the water of the river precipitated itself into a newly formed chasm and only made its reappearance near the Presidio de San Eleezario. This loss of the Rio del Norte remained for a considerable time; the fine plains which surrounded the Passo and which are intersected with small canals of irrigation, remained without water and the inhabitants dug wells in the sand with which the bed of the river was filled. At length after the lapse of several weeks the water resumed its ancient course, no doubt because the chasm and the subterraneous conductors had filled up.

From this it seems fair to infer that the Spaniards of 1540 were witnesses of a phenomenon which repeated itself in 1752.

Springs have also been known to be changed, in that region, by earthquake shocks, and it would, therefore, appear that in the past there has been considerable instability in the water supply. There is a probability that a large branch entered the Rio Grande, from the northeast, just above El-Paso, in Coronado's time, which has since vanished, leaving only marshy spots where it once ran. These changes in volume of springs and in streamflow have, it is needless to say, an important bearing on the archeology of that district.

F. S. DELLENBAUGH.

SPECIAL ARTICLES.

BIOLOGICAL SURVEY OF THE WATERS OF SOUTHERN CALIFORNIA BY THE MARINE LABORATORY OF THE UNIVERSITY OF CALIFORNIA AT SAN DIEGO.

THE marine biological survey undertaken by the Department of Zoology of the University of California of the Pacific Ocean adjacent to the southern coasts of the state in 1901,* continued for six weeks in the summer of 1902 at San Pedro, with a limited amount of shore work and some attention to the plankton of San Pedro harbor, and transferred in the summer of 1903† to San Digeo or, more specifically, to Coronado on the peninsular side of the Bay of San Diego was again taken up during the holiday intermission of the university for a period of three weeks from December 15, 1903, to January 6, 1904. The committee of the Chamber of Commerce of San Diego, which raised the funds for the work of the preceding summer provided also, in the

* W. E. Ritter, 'A Summer's Dredging on the Coast of Southern California,' SCIENCE, Vol. XV., p. 53, 1902.

† W. E. Ritter, 'Preliminary Report on the Marine Biological Survey Work carried on by the Zoological Department of the University of California at San Diego,' SCIENCE, Vol. XVIII., pp. 360–366, 1903.

main, for the explorations of the winter. The laboratory was again opened in the boat-house, partially equipped and courteously placed at the disposal of the Chamber of Commerce by the Coronado Beach Company. The laboratory was fortunate in again securing the services of Mr. Manuel Cabral as collector, and the power boat *St. Joseph,* by means of which it was possible to have collections made in the early morning ten to fifteen miles off shore from Coronado brought to the laboratory early in the forenoon for the day's work.

The climatic conditions were ideal for winter work. Bright sunshine every day and an equable temperature obviated the necessity of artificial heat in the laboratory, and no storms interfered with the regular trips of the collector. Tides at this season of the year are also favorable, reaching lowest levels in the afternoon, while in the summer the best tides for shore collecting all occur before daybreak or early in the morning. The persons engaged in the survey and subjects of their investigations were as follows: Professor W. E. Ritter, director of the laboratory, *Balanoglossus, Tornaria,* pelagic and littoral tunicates; Assistant Professor Charles Kofoid, pelagic Protozoa; Dr. Alice Robertson, Bryozoa and Copepoda; Mr. L. H. Miller, assistant in zoology, and Mr. R. D. Williams, a graduate student, working with Professor Kofoid on the Protozoa and Miss Margaret Henderson continuing her work of last summer with Dr. H. B. Torrey, on the pelagic Cœlenterata.

The physical observations made in the previous summer by Mr. H. M. Evans on temperatures and salinity were continued this winter by Professor W. T. Skilling, of the San Diego Normal School. These observations show, as might be expected, that the shallow bay waters have cooled down more than the surface waters of the adjacent ocean. Whereas last summer the bay waters were 4°–5° C. warmer than the ocean, they were in midwinter 1°–2° cooler. Temperature in summer in the bay ranged from 22.7° to 26.7°, in winter from 13.3° to 14.7° C. Surface waters in the adjacent ocean in summer ranged from 18° to 22.5° except during a cold spell August 27–31, when they fell as low as 14.8°. In winter the range was from 14.6° to 15.6°.

The salinity also declined slightly below the summer determinations, the average of the readings, reduced to Dittmar's standard, of ocean water at Coronado pier falling from 1.02455 to 1.023748; of the middle portion of the bay near the mouth of Glorietta Bight at Coronado falling from 1.02546 to 1.024274. Determinations of salinity were also made in the mid-channel between Coronado and San Diego at the ferry crossing, yielding an average of 1.023927.

The biological explorations of the winter were again directed in the main to the plankton. Quantitative examinations were made of the plankton of the Bay of San Diego near the laboratory and of Glorietta Bight. Surface waters of the ocean off-shore from Coronado were also examined, but the principal field of operations was 'Cabral's bank,' an uncharted area about ten miles off Point Loma with 60–90 fathoms of water, known to local fishermen. A number of hauls were also made in the adjacent deeper waters of the Coronado submerged valley.* In all of these localities there was a noticeable decrease in the quantity of the plankton as compared with that taken in similar hauls of our nets in midsummer. There was a marked diminution in the quantity of diatoms and a still more pronounced reduction in the volume and variety of the Peridinida. *Gonyaulax,* which was so abundant in August as to color the water and cause an appreciable odor along shore, was found in living condition but a few times though empty skeletons were still not infrequent. The Tintirnidæ, on the other hand, were abundant in the ocean waters and showed marked increase over summer ratios in the bay. The Radiolaria were also, relatively to summer conditions, greatly increased in numbers and variety in all collections made some distance off shore, but were not common

* George Davidson. 'The Submerged Valleys of the Coast of California, U. S. A., and of Lower California, Mexico.' Proc. Calif. Acad. Sci. Geol., Third Ser., Vol. I, pp. 73–103, Pls. 2–10, 1897.

in bay and coastal waters. The Acantharia, which in summer abound in shore and bay waters, were less abundant everywhere this winter. The Spumellaria were also somewhat reduced in frequency, while the Nassellaria were greatly increased and diversified in waters near the 100 fathom line, where the major part of our oceanic collections were made, rivaling if not surpassing in richness the *Challenger* collections from the tropical Pacific as reported by Haeckel.

The Cœlenterata are reported by Dr. H. B. Torrey to be fewer in the winter collections, both as species and as individuals, in all orders but the Siphonophora, where numbers were much larger, especially of *Diphyes*.

The Entomostraca were less abundant than in summer, especially in shore waters. *Sapphirina* was found several times and an apparently new 'peacock form' allied to *Calocalanus* was obtained. *Cyphonautes* was very common in all collections, and Ophio-, Echino- and Asteroplutei were not infrequent, indicating breeding of many echinoderms at this season of the year.

The pelagic Mollusca were more numerous than in summer. *Creseis* and young *Pneumodermon* were found, and young *Pleuropus* were very abundant in the oceanic collections.

Professor Ritter reports the presence of *Salpa, Doliolum* and *Appendicularia* though less abundant than in the summer. A small *Tornaria* of uncertain relationships was found this winter in small numbers on the bank where the large *T. ritteri* was found last summer.

A few collecting trips were made at low tides and some dredging was done off shore and in the harbor. *Ciona* was exceedingly abundant and of great size in loose colonies on the sand in the shoal waters of the harbor, and *Perophora* and sponges were in great breeding activity on the floats and piles near the laboratory. *Amphioxus californicus* was again collected on the 'middle ground' near the mouth of the harbor in shelly deposits, and *Dolichoglossus* was found in great abundance on the mud flats about the bay associated with another possibly new member of the genus. *Cerianthus* and *Renilla* were collected on the sand and the mud flats exposed at low tide. Many annelids were breeding in the mud flats about the harbor and in the False Bay. New collecting grounds on the ocean front near Pacific Beach were found on rocks exposed at low tide, which equal in richness and in variety of their fauna anything thus far found on the coast of California south of Monterey Bay.

One of the most noticeable changes in the local fauna was an unusual development of a large bryozoan, *Bowerbankia,* in the harbor, forming masses often several feet in diameter. This species was dying out rapidly during our stay at Coronado, living zooids being very rare on the colonies. Another remarkable change was the development of *Donax californicus* in great numbers at Pacific Beach, where on a gently sloping sandy shore in the notoriously heavy breakers of the region these little lamellibranchs were found in enormous numbers, literally covering the beach on a strip several miles in length and fifty yards or more in width. The levels at which they occurred would bring them into the turmoil of the breakers with every tidal recession during plus tides and leave them exposed on the beach for several hours during minus tides. A similar occurrence at Long Beach near Los Angeles several years ago led to the formation of a fertilizer corporation to exploit these resources of the sea, but *Donax* disappeared before the stock was floated, as mysteriously as it came. Associated with *Donax* in what seems to be a commensal relationship is an undescribed Campanularian hydroid attached to the shell in small tufts between the umbo and siphons. This was sufficiently abundant to add an appreciable color to the banks of *Donax in situ* on the beach.

Chimæra was caught on the fishing banks and *Gyropleurodes* was taken in the Bay.

A great abundance of animal life is thus available at San Diego in winter months for the biologist, and the desirability of this location for the establishment of a marine station open throughout the year grows increasingly evident.

In furtherance of this object a Marine Biological Association was formed at a public

meeting of interested citizens of San Diego and vicinity September 27, 1903.

The by-laws as adopted designate the purposes of the organization and in part are as follows:

"The organization shall be called the Marine Biological Association of San Diego, for the purpose of securing the foundation and endowment of a scientific institution to be known as the 'San Diego Marine Biological Institution.'

"The general purposes of the institution shall be to carry on a biological and hydrographic survey of the waters of the Pacific ocean adjacent to the coast of South California, to build and maintain a public aquarium and museum and to prosecute such other kindred undertakings as the board of trustees may from time to time deem it wise to enter upon.

"The founding of the institution having been perfected and its endowment secured, the whole or such part thereof as may in the judgment of the trustees seem best shall, under such conditions as the trustees may impose, be transferred to the regents of the University of California, to become a department of the university coordinate with its already existing departments.

"The officers of the association shall be a president, vice-president, scientific director, secretary and treasurer. In addition there shall be a board of trustees consisting of seven members, three of whom shall be the president, vice-president and scientific director."

Officers were elected as follows:

President—Homer H. Peters.
Vice-President—Miss Ellen Scripps.
Scientific Director—Professor W. E. Ritter.
Secretary—Dr. Fred Baker.
Treasurer—Julius Wangenheim.
Additional Directors—E. W. Scripps and James MacMullen.

At a winter meeting of the board of trustees funds were guaranteed for three years which will enable the station to continue its work and expand it somewhat, perhaps to the extent of keeping the station in partial operation throughout the year in charge of a resident naturalist or fellow during the interim between the summer and winter operations. A public spirited patron of the laboratory has offered to grant the laboratory the use of a nineteen ton schooner, the *Loma*, former pilot boat of the port, equipped with power, for purposes of collecting, sounding, dredging, etc., and also to erect a temporary building for accommodation of the laboratory which may be located at La Jolla, fifteen miles from San Diego on the ocean front. The permanent location of the buildings will not be determined until a thorough exploration of several possible situations shall have been made.

Charles Atwood Kofoid.

THE NECESSITY FOR REFORM IN THE NOMENCLATURE OF THE FUNGI.*

The nomenclature question is almost entirely one of expediency. If the prevailing custom in making plant names has led to the establishment of a nomenclature that satisfactorily fills the requirements for accuracy and stability, and if it points out unfailingly the proper procedure where our increased knowledge of any given group of plants necessitates the modification of our ideas of generic limits, then any change in traditional methods, or any attempt to substitute other generic names for those now commonly used, would be a folly so great as to approach lunacy. Let us see what the facts are as regards the fungi. Fries, in his classical work 'Systema Mycologicum,' the final volume of which was published in 1829, recognized 243 genera of fungi. In the 'Sylloge Fungorum' of Saccardo, the eight original volumes completed in 1889 contain 1,685 genera and 31,927 species. Supplementary volumes have appeared from time to time, the last in 1902, bringing the total number of recognized genera up to 2,348 and the species to almost 50,000. The treatment of the fungi by Schroeter, Lindau, Hennings Dietel and Fischer in Engler & Prantl's 'Pflanzenfamilien' was completed in 1900. The usage here differs radically from that of Saccardo in many respects and the number of genera accepted is only 1,811, or 537 less than are recognized by Saccardo. A

* Read before the Botanical Section of the American Association at the St. Louis meeting.

comparison of the generic treatment in the two works has not been attempted for all the groups. The following, however, will show that this difference in numbers is not a mere multiplication of genera by Saccardo. Of the 54 genera of the Agaricaceæ given by Hennings in Engler and Prantl, 15, or nearly 28 per cent., are not recognized by Saccardo, many of them not appearing even as synonyms, though his work is two years the later. If we reverse the comparison, the showing for uniformity in modern usage is much worse, since of the 82 genera given by Saccardo only 41, or exactly 50 per cent., are recognized in Engler and Prantl. This is certainly a case where it will be difficult to say what is the 'prevailing usage.' Taking the Hymenomycetes as a whole, Engler and Prantl give 147 genera, 25 of which, or 17 per cent., are not recognized by Saccardo. If these glaring differences cause us to investigate as to which of these works is based on the more logical and consistent usage, and, therefore, which is the safer nomenclatorial guide, we are forced to the conclusion that neither of them follows any recognizable or consistent rule of nomenclature. The case of each genus seems to have been settled on an independent basis and according to the whim of the moment. Doubtless the claim would be made for each work that the names were selected on the basis of priority, but priority has been flagrantly and repeatedly violated in both of them.

Again is the 'prevailing usage' furnishing us at the present time with a safe rule for the establishment of new genera on a sure and stable basis? That this is no idle question is shown by the vast increase of over 2,000 genera since 1829 and of 663 since 1889, if we count on the basis of the 'Sylloge,' and the tendency is for the still more rapid multiplication of genera in the near future. Every revision of a large genus in these days results in breaking it up into smaller generic groups. It is vitally important that this shall be done on some basis that will prove stable. What is really being done is illustrated by a recent revision of *Ravenelia*. After an exhaustive and critical study of the species the author very properly decides to break up the genus. He leaves the majority of the species under the old generic name and proposes new names for the smaller segregations. Now it happens that *Ravenelia* was founded on a single species, *R. glandulosa*. In the proposed revision this species falls in one of the smaller groups and is no longer called a *Ravenelia,* while that name is applied to a group of species none of which were included under it by the author of the genus. If priority is to be more than an empty name such practices can certainly not be allowed to stand unchallenged, yet the author could point to hundreds and hundreds of precedents to justify his usage. In fact, we must admit that this usage has been the prevailing one ever since the time of Linnæus. The chaotic condition that must inevitably be produced by following this so-called 'method of residues' is well illustrated by the following figures taken from my work as a member of the nomenclatorial committee in finding the types of the older genera of fungi. I have listed 485 names that were proposed between 1753, the first edition of Linnæus's 'Species Plantarum,' and 1821, including the first volume of Fries's 'Systema Mycologicum.' Of these, 242, or one half, are to be rejected for various reasons. Some are hyponyms, never having been associated with a recognizable binomial species; some are typonyms, being based on species already used as the types of other genera; some were only proposed as subgenera, and some were based on sterile mycelia, monstrosities, insect work or plants that are not fungi. The remaining 243 names are available for use at the present time. The types of these have been determined according to the code proposed at the Washington meeting. One hundred of them, or 41 per cent., were monotypic, being based on a single species. In 135 of them, or 55 per cent., the type was determined by page priority. Nine are historic types taken from pre-Linnæan authors and 4 were inferred from the form of the specific name. Of these 243 available names, 118 are used by Saccardo in their proper historic sense, being still associated with their original type species. In the other 125 cases the names are either not

given by Saccardo or they have been shifted from their proper historic use and do not now contain their original types. Of course, in some cases this is correct, since the list includes some metonyms where the type falls within the limits of an earlier valid genus. The number of these has not been determined, since it will depend on the conception of generic limits and will necessarily change from time to time with the increase of our knowledge. As genera are now recognized it probably does not exceed 20 per cent. This would leave an estimated 218 valid genera to 100 of which, or 45 per cent., the oldest available name is not applied by Saccardo. Of the 100 monotypes 58 appear in Saccardo under their original name, while 42 must be sought under other genera. In one case noted, five genera have at different times been founded on the same type species, and three of these names are still doing duty in both Saccardo and Engler and Prantl.

Glaring inconsistencies like those might be cited almost endlessly. The above, however, is sufficient to show conclusively first, that we have at present no widely accepted 'prevailing usage' in regard to the names of fungus genera; and secondly, that the usage that has prevailed in the formation of generic names has not led to stability or to the establishment of any logical system of procedure. In fact, the existing condition is so confused and anomalous as to imperatively demand an immediate and sweeping reform. Doubtless all will now agree that any rational system of nomenclature must be based strictly on priority. This in itself is a long step in advance, for only a generation ago the foremost systematists laid less stress on priority than on the supposed appropriateness of a name. The unfortunate result of their practices has just been passed in review. While all will agree on the basic principle of priority there will be divergence of opinion when the attempt is made to formulate a code of rules for applying it. The ideas and methods of the earlier writers were so diverse from our own that it is impossible to bring their work into harmony with ours without adopting rules and methods that are necessarily more or less arbitrary. It is perfectly clear that they had no idea of the type of a genus or a species in the sense in which we use the word to-day. Their 'type,' in so far as they had one, was a mental concept; and yet if we are to prevent this endless shifting of generic names from one group of plants to another, it becomes necessary to tie down these ancient concepts to the material basis of a single species. The exact way in which this is to be done really matters very little. No rule or system of rules can possibly be devised which, if consistently followed, will not throw out or change the meaning of many of the names accepted by modern writers. Any attempt at reform based on a method devised for the purpose of 'saving names' can only end by adding to the existing confusion. Let us then nerve our minds to the point of seeing not only any, but, if necessary, all of our most favored names sacrificed to consistency, and unite in adopting the simplest and most direct code of rules that can be agreed upon. When this is once done and its provisions are carried out in good faith we shall by the one cataclysmic effort have placed the nomenclature of our science on so firm and stable a basis that we need no longer dread the appearance of each succeeding contribution to mycological knowledge on account of the changes in names that have been so constant and so annoying an accompaniment of each forward step in the past.

F. S. Earle.

New York Botanical Garden.

ENERGETICS AND MECHANICS.

Within the past ten years energetics has been brought to the front as furnishing a systematic account of phenomena that are connected most directly with quantitative relations of energy, and of its transformations. To any one who has stood aloof from the polemic between the 'energetic' and the 'forcive' view, it must seem proved that the former has rendered a permanent service to physics, by devising and putting into circulation forms of statement that are freed from superfluous hypothetical assumptions, and brought closer to the foundations of natural science in ascertained facts. For example, the

current of thought, simplifying and clarifying in this sense, that runs through Professor Ostwald's 'Naturphilosophie' is undeniable, whatever particular attitude between full acceptance and opposition we may take toward the author's expressed or implied philosophy. But in summing up the gain due to such movements, that lesson from history must not be lost sight of which teaches that a new interpretation of phenomena rarely supersedes the previous views; it most often supplements and modifies them. So here, while we may accept the suggestion from energetics, and cry good riddance to a cumbrous apparatus of molecular forces, premature, at least, for our present state of experimental knowledge and, perhaps, finally illusory, it is not required by consistency to follow the extremists in their tendency to banish the conception of force completely, nor need we even derive those parts of mechanical doctrine which are stated through equations of motion from an exclusive source in energy relations.

It is something, of course, that we have a direct and roughly quantitative appreciation of force through muscular sensation; but further, attacking the matter more broadly, several points may be urged in restraint of relegating force to the scientific lumber-room. First, let us grant fully one great advantage of an energy equation: that it renders possible a true statement of relation between conditions at the boundaries of an interval, while we are ignorant of the internal mechanism, *i. e.* the details within the interval. But let us notice, also, that this is coupled with a corresponding disadvantage. The energy equation is not immediately capable of recording internal details, even where the process has been traced continuously or minutely; and to this extent it fails to represent completely our acquaintance with those cases. In parallel with the energy equation (the integrated form), therefore, the force equation or its equivalent (the differential form) is then justified and requisite. That is, though it is well to acknowledge ignorance and bridge the gap with the energy equation, yet it would be pedantic to use equations of that type exclusively, and thus ignore knowledge that we really possess. Secondly, it is part of the general intellectual position which has led to the development of energetics, that the introduction and use of physical quantities are to be determined according to their convenience and sufficiency. Now it is true and interesting that the condition of equilibrium (zero value of accelerations) can be described as a compensation of one form of energy by another (Ostwald, passim); but that does not settle any question of practical convenience in the definite calculation of conditions for equilibrium. And it is precisely when those conditions obtain, that one factor of energy becomes indeterminate or unimportant, leaving attention to be concentrated upon the remaining factor. Hence the universal procedure in measuring the forces, pressures, etc., that are practically essential elements in a state of balance, through the whole range from constructing the piers of a bridge to applying D'Alembert's principle. For the purpose of physics it is not always enough to know that an algebraic sum is zero; the magnitude of the self-neutralizing terms is of importance. To be sure, this particular aspect of the situation may be met by using freely coordinate derivatives of energy, and thus narrowing the question to the choice between the directer and the more artificial introduction of the necessary forces. But even this resource would not occupy the vacant field entirely; a third point remains to be considered. What account does the view peculiar to energetics give of normal forces, those actions which guide moving bodies without directly affecting their energy of motion? The scalar kinetic energy is unaffected by mere change of direction; there is no measurable exchange of energy (apart from friction) between a body moving with constant speed in a curved path and the guiding mechanism. Yet these are not instances of equilibrium, either, describable in terms of compensating forms of energy; none of the extensions of energy equations to cover tangential forces by means of coordinate derivatives apply here. This seems to be the weakest spot in the scheme of energetics, at which it stands most in need of supplement by direct use of equations of motion. Everywhere

in dynamics the directive forces play a prominent part. Nor is this necessarily confined to molar mechanics; wherever the generalized equations of Lagrange are proved to be serviceable, the significance of the term $\partial E/\partial s$ cannot be overlooked. It registers the occurrence of directive or guiding forces, as a type, in conjunction with those whose form $(d/dt \cdot \partial E/\partial v)$ indicates their relation to changes of energy.

Frederick Slate.
University of California,
February 24, 1904.

QUOTATIONS.

PRESIDENT ELIOT.

'Nature's patient ways shame hasty little man,' a sentence from one of President Eliot's lectures, is the keynote to much of his work; for he has made nature's patient ways his own. He celebrates to-morrow (March 20) his seventieth birthday, and this year, also, the thirty-fifth anniversary of his presidency of Harvard. For an estimate of his achievements this is neither the place nor the time: the limits of an editorial article are too narrow; and his labors are, we trust, far from an end. *Serus in cœlum redeat.* But we add our hearty congratulations to those of Harvard graduates, friends of learning from all colleges and schools, and worthy citizens in every walk of life; and we seize this moment as suitable for dwelling on two or three aspects of President Eliot's career. He stands among the foremost citizens of the United States; were there a common denominator by which one could measure men of widely different talents and callings, he might rank the very first. This success is indubitably due in large part to a power which has wrought, like the force of a glacier, without haste, and without rest.

It is as an educator that he enjoys the widest fame. For more than a third of a century—a period of unexampled material progress—in a country which has leaped forward rather than developed, he has been at the head of our oldest and richest university. He has thus enjoyed a unique opportunity to set his stamp upon the educational system of a nation; and this opportunity he has employed to the uttermost. The principles which he intended to follow he laid down with precision in his Inaugural Address in 1869; from those principles he has never swerved. He declared: "This university recognizes no real antagonism between literature and science, and consents to no such narrow alternatives as mathematics or classics, science or metaphysics. We would have them all, and at their best." Against the old hard and fast curriculum—"one primer, one catechism, one rod for all children"—he set his face unflinchingly, and proceeded to build up the elective system, which at Harvard already rested on a firm foundation. The opposition within his faculty and without was determined, sometimes bitter. His theory that "a well-instructed youth of eighteen can select for himself—not for any other boy, or for the fictitious universal boy, but for himself alone—a better course of study than any college faculty, or any wise man who does not know him and his ancestors and his previous life, can possibly select for him"—this theory was assailed and ridiculed as individualism run mad. But President Eliot held to his course, and he has seen his theory accepted in every important college of the country. He has weathered the storm that raged about him twenty years ago, and has anchored in the desired haven.

As champion of a movement which put sciences and modern languages in 'fair competition' with the classics, he has urged unceasingly more skillful instruction in these new subjects. In his Inaugural, he bluntly told the 'scientific scoffers at gerund grinding' that 'the prevailing methods of teaching science the world over, are less intelligent than the methods of teaching language.' Experimentation in the laboratory, original investigation, drill in accurate observations, he has made the burden of many addresses and reports. Moreover, it is owing largely to his efforts that the standard of professional schools has been raised, and that secondary and grammar schools are now reorganizing their programs according to the modern idea of developing the aptitudes of the individual. But it is upon English that he has laid the greatest stress. He began his presidency by

quoting Locke's complaint as to the neglect of the mother-tongue; and he has returned to the theme again and again. At Harvard he has built up an English department that has been a stimulus to every other college and to schools of all grades.

In this vast enterprise, President Eliot himself, the moving spirit, has had neither the authority nor the will to force the action of faculties or committees. More than once he has seen his opinions thrown into the arena of open debate and voted down. But, convinced that his views, if sound, will ultimately triumph, he has waited with Olympian calm for the march of events. Though the immediate effect of the changes has in some cases seemed to be chaos, he has never been discouraged; he has shown that, to rearrange a curriculum, to train competent instructors in new subjects, to establish traditions of mental discipline, will be the task of generations yet to come.

In his discussion of public questions he has insisted upon the right of the individual to attain his highest intellectual and moral development, unchecked by a cast-iron regimen of studies, or by intolerance in church or state. His criticisms of organized labor have voiced the conviction of our sanest publicists, that 'democracy must profoundly distrust the labor union's too frequent effort to restrict the efficiency and the output of the individual workman.' This doctrine of individualism, a tenet of the liberals of the old school, is falling into temporary decay; it is opposed by certain captains of industry, who want to crush out the individual and pile merger upon merger; it is opposed by the trades unionists, who condemn all laborers to the lock-step; yet President Eliot has steadily, with candor and courage, striven for the basic principle of our Declaration of Independence.

These are the achievements, these the qualities that have won him, year by year, a wider recognition; have transmuted cold respect into affection. In the earlier days of his presidency a reserve of manner, absorption in details of administration, and a frank indifference to the gusts of undergraduate sentiment made students regard him with an uncomfortable awe, as if he were a sort of Iron Chancellor in an empire of education, or—to recur to a former comparison—as if he were really a glacier. Time has proved the falsity of this first impression; has shown that no college president has endured with more serenity and good humor the criticism of his colleagues; that the springs of his kindness are as unfailing as the waters that melt from the eternal ice. He has reached the goal of his ambition. In describing Dr. Asa Gray's life as 'happy,' he declared: "It is the greatest of human rewards to be enfolded, as years advance, in an atmosphere of honor, gratitude and love." That greatest of rewards President Eliot himself has reaped in full measure, while his eye is not dim nor his natural force abated.—*New York Evening Post.*

NOTES ON INORGANIC CHEMISTRY.

WATER GAS IN THE CHEMICAL LABORATORY.

A PAPER was recently read before the Society of Chemical Industry by Masume Chikashige and Hitoshi Matsumoto on the defects of uncarburetted water gas as a fuel for laboratory use. Inasmuch as water gas is more or less extensively used in cities and as small local water-gas plants are easily installed, extended studies of its use have been made by the authors, resulting in its condemnation. Among the reasons given for these conclusions are the following, which seem most important.

While the water-gas flame is non-luminous and always powerfully reducing, it is often desired to have a smoky flame temporarily, which is impossible with this gas, nor is it possible to produce a flame to any considerable extent oxidizing in its nature. The air openings in a Bunsen burner are useless, as it is not possible to mix more than a very slight proportion of air with the gas without producing an explosive mixture. The intense heat of the flame, far higher than can be obtained with coal gas, is not an unqualified advantage, as it occasions the rapid destruction of wire gauze and copper vessels; copper air baths and water-baths are rapidly destroyed, unless provided with cast-iron bottoms. Owing to the presence of carbon monoxid, nickel vessels are quickly corroded, some crucibles being burnt completely through in a single

operation. Platinum vessels are seriously damaged, becoming brittle, and at the same time increasing in weight, owing to the deposition of iron from the iron carbonyl formed in the passage of the gas through iron pipes. A similar deposit, which can not be wiped off, is formed on the bottom of porcelain crucibles, precluding the use of such crucibles in quantitative analysis. It was found that a very considerable quantity of unconsumed carbon monoxid escaped into the air, so that this could easily be injurious to health. In a laboratory where thirty coal-gas burners may be kept going without detriment to health, hardly eleven water-gas burners can be used with impunity. In the ensuing discussion of the paper it was suggested that where the water gas is carburetted, as is usual in this country, it is probable that it is less objectionable as a laboratory fuel.

YELLOW ARSENIC.

THE yellow modification of arsenic, which has been observed by several chemists, has been submitted to a careful examination by Erdmann and Unruh, and their results are published in the *Zeitschrift für anorganische Chemie*. The yellow arsenic corresponds to white phosphorus, and is produced by rapidly cooling the vapor of arsenic. In practice the best method was found to be sublimation in a tube of aluminum in an atmosphere of inert gas. The fumes are cooled rapidly by absorption in carbon bisulfid, in which yellow arsenic is soluble. When a saturated solution is cooled to $-70°$ it deposits the yellow arsenic in the form of a yellow powder, which can be preserved at this temperature without change if kept in the dark. When exposed to light, even in solution, it is rapidly changed to ordinary arsenic. After a time a brownish-red precipitate is formed in the carbon bisulfid solution which seems to be a fourth modification, and reminds one of red phosphorus. The molecular weight of the yellow arsenic was determined, and the molecule corresponds to As_4.

COPPER CYANID SOLUTIONS.

IN the same journal is a paper by F. P. Treadwell and C. v. Girsewald on the colorless solution of copper cyanid, which is not precipitable by hydrogen sulfid, and which is very familiar to all students of qualitative analysis. The compound present in this solution is variously given in different text-books, some considering it merely a double cyanid of bivalent copper and potassium, as $K_2Cu(CN)_4$, while others affirm that the copper is present in univalent form, being reduced by the potassium cyanid. For this the formula $KCu(CN)_2$ is sometimes given. In both cases it appears wholly a matter of mere conjecture. The authors studied solutions containing various proportions of copper and potassium cyanid, and arrived at the conclusion that the salt present is $K_4Cu_2(CN)_6$, though the salt itself was not isolated. The complexity of the ion which is not decomposed by hydrogen sulfid was determined to be $[Cu_2(CN)_6]^{IV}$, by the use of cryoscopic methods.

CORROSION OF IRON WATER MAINS.

AN interesting case of corrosion is reported from Frankfurt in the *Zeitschrift für angewandte Chemie*, by Martin Freund. This pipe contained in places holes as large as the palm of the hand. On the edges of these holes the iron had been converted into a dense, dark gray, soft mass resembling graphite. Analysis showed the mass to be composed of ferrous phosphate, ferrous silicate, carbon, and ten per cent. of metallic iron. As the surrounding soil could not have supplied the phosphorus or silicon, it appeared that all the materials had come from the iron itself. By the action of stray electric currents the phosphorus and the silicon of the iron had been oxidized to phosphate and silicate. In order to test this supposition, Freund subjected a portion of the cast iron of the pipe as anode to the action of an electric current in a dilute salt or gypsum solution, and found that in a short time the iron became coated with a deposit containing phosphate and silicate of iron, and in every respect resembling the corrosion product of the pipe. J. L. H.

A QUARTERLY ISSUE OF THE 'SMITHSONIAN MISCELLANEOUS COLLECTIONS.'

THE Smithsonian Institution has commenced the publication of a Quarterly Issue

of its 'Miscellaneous Collections,' 'designed chiefly to afford a medium for the early publication of the results of researches conducted by the Smithsonian Institution and its bureaus, and especially for the publication of reports of a preliminary nature.' The first number of the Quarterly Issue is a double one and contains seventeen articles, ranging in size from 1 page to 73 pages, in addition to notes on the activities of the institution, its collections, etc., the whole accompanied with fifty-six plates and numerous text figures. The scope of the journal is broad, the first issue embodying articles on mammalogy, astrophysics, paleontology, archeology, geology, ornithology, ichthyology, ethnology, etc., thus covering a considerable range of scientific subjects. The number in hand opens with a description of 'Seventy New Malayan Mammals,' by Gerrit S. Miller, Jr., based on collections made and presented to the National Museum by Dr. W. L. Abbott. Mr. C. G. Abbott presents the results of 'Recent Studies of the Solar Constant of Radiation,' conducted at the astrophysical observatory of the institution, under the direction of Secretary Langley. Another paper by Mr. Abbott describes 'The New Cœlostat and Horizontal Telescope of the Astrophysical Observatory,' in which are given the results obtained with a device designed by Secretary Langley for the purpose of 'churning' a column of air traversed by a solar beam, with the view of reducing the 'boiling' or confusion of all parts of the solar image due to variability of the strata of air traversed. Dr. F. W. True presents some photographic illustrations of 'Living Finback Whales from Newfoundland,' these being the first photographs of living whales in American waters that have thus far been published. Brief descriptions of 'A Skeleton of Hesperornis,' and 'A New Plesiosaur,' by Mr. Frederic A. Lucas, are given with plates, and Mr. W. H. Holmes illustrates and compares the designs on some remarkable 'Shell Ornaments from Kentucky and Mexico.' A noteworthy specimen of a 'Glacial Pothole in the National Museum' is described by Mr. George P. Merrill, who explains the method by which the specimen was procured. 'Some Notes on the Herons of the District of Columbia,' by Mr. Paul Bartsch, who made a systematic survey of two heron colonies and conducted experiments with a view of solving some of the problems of bird life, is of special interest. Dr. J. Walter Fewkes gives a 'Preliminary Report on an Archeological Trip to the West Indies,' in 1903, describing particularly the remarkable objects of stone, bone, shell, wood and pottery which he collected during the trip, and giving an insight into their various uses. Dr. C. M. Child, of Chicago University, describes the 'Form-regulation in Cœlentera and Turbellaria,' of which he made a special study during his occupancy of the Smithsonian seat at the Naples Zoological Station, and Dr. Carl H. Eigenmann introduces some 'New Genera of South American Fresh-water Fishes, and New Names for Some Old Genera.' Of timely interest is the account of 'Korean Headdresses in the National Museum,' by the late Foster H. Jenings, in which are described and illustrated twenty-four varieties of Korean hats and other headgear, including headband buttons and hatpins for topknots. A brief history of the 'Hodgkins Fund of the Smithsonian Institution,' and of what has been accomplished with its income toward 'the increase and diffusion of more exact knowledge in regard to the nature and properties of atmospheric air in connection with the welfare of man,' bears the name of Helen Waldo Burnside, and is accompanied with an illustration of the beautiful Hodgkins medal. Mr. A. B. Baker gives an account of 'A Notable Success in the Breeding of Black Bears,' which is of special interest to those having charge of animal collections. Of quite a different theme is Dr. James M. Flint's 'Chinese Medicine,' which briefly explains the origin of medicine and the theory of disease in the Celestial Empire. The last of the series of articles consists of 'Notes on the Rocks of Nugsuaks Peninsula and its Environs, Greenland,' by W. C. Phalen, the remaining pages of the journal being occupied by brief descriptions of various activities of the institution and their results.

BOTANICAL WORK IN THE PHILIPPINES.

Since the American occupation a considerable amount of botanical work has been accomplished on the Philippine flora, under the auspices of the insular government, and in the near future, due to the fact that the appointment of an assistant botanist and two collectors was authorized by the civil commission some time ago, the work will be greatly increased.

Shortly after the organization of the Forestry Bureau in May, 1900, some botanical work was undertaken by Regino Garcia, who had been an assistant in the Spanish Forestry Bureau. Little work, however, of lasting value was accomplished in this office. In April, 1902, the Bureau of Agriculture was organized, and Elmer D. Merrill was appointed botanist. In July, 1902, he was also made botanist to the Forestry Bureau, while in July, 1903, he was transferred to the Bureau of Government Laboratories, when an assistant and two collectors were authorized. The object in transferring the work to the Government Laboratories was to get all work of a similar nature into one institution, and organize a thoroughly equipped botanical laboratory. In November, 1903, Dr. E. B. Copeland was appointed assistant botanist, and Mr. A. D. E. Elmer one of the collectors, the second collector not having as yet been appointed.

In the past two years under Mr. Merrill's direction a herbarium, exceeding 8,000 sheets, has been formed and for a large part identified, a well-equipped botanical library has been established and the following publications have been issued: 'Botanical Work in the Philippines,' 'Report on Investigations made in Java in the Year 1902,' 'A Dictionary of the Plant Names of the Philippines,' 'New or Noteworthy Philippine Plants,' 'The American Element in the Philippine Flora.' The first article was published as a bulletin from the Bureau of Agriculture, the second as a bulletin from the Forestry Bureau, and the last three as bulletins from the Bureau of Government Laboratories.

At the present time, in addition to the work on the Philippine flora being prosecuted under the auspices of the Philippine government, Mr. R. S. Williams is collecting in Luzon for the New York Botanical Garden and Dr. H. Hallier is collecting in Mindanao for the Hamburg Museum. A considerable amount of botanical material was secured by various employees of the Philippine Exposition Board, this material, with the exception of one set retained in the herbarium of the Bureau of Government Laboratories in Manila, having all been forwarded to St. Louis.

SCIENTIFIC NOTES AND NEWS.

M. Henri Becquerel, professor of physics at the Paris Ecole Polytechnique, has been elected a correspondent of the Berlin Academy of Sciences.

The University of Chicago has celebrated this week its fiftieth convocation. It has given its LL.D. to five German professors, including Professor Paul Ehrlich, director of the Royal Prussian Institute of Experimental Therapeutics at Frankfort-on-the-Main.

The Senate of the University of Glasgow has resolved to confer its Doctorate of Laws on Mr. G. F. Deacon, civil engineer, of London; on Mr. J. H. Muirhead, professor of mental and moral philosophy in the University of Birmingham; on Dr. W. Stirling, Brackenbury professor of physiology and histology at Owens College, University of Manchester, and on Sir William Taylor, M.D., director-general of the army medical service.

The Turin Academy of Science has awarded one half of the Vallauri prize of $6,000 to Professor Giovanni Battista Grassi, of Rome, in recognition of the value of his researches on malaria.

Dr. George B. Parkin, representing the trustees of the will of the late Cecil Rhodes, sailed for New York on March 16 to assist in the holding of examinations in the United States and Canada for the Rhodes scholarships at Oxford.

Dr. R. O. E. Davis, instructor in chemistry in the University of North Carolina, having been granted a year's leave of absence, sails on April 16 for work in the laboratories of Professors Ostwald and van't Hoff.

THE daily papers state that on the French Line steamship *La Savoie,* which arrived from Havre on March 19, was a commission of men of science to study geology and for general scientific research. Professor Googg of the High School of Commerce at Geneva; Lieut. Bourée of the French navy, Commander Massari of the Italian navy, M. Richard, M. de la Burahaye, Count d'Audiffret-Pasquier, and M. Langlois comprise the commission. The officers were granted leave of absence to come to this country.

PROFESSOR H. F. OSBORN has accepted an invitation to give an evening lecture before the British Association at Cambridge, on August 20, and has chosen as his subject 'The Evolution of the Horse.' He will also lecture before the International Zoological Congress at Berne, Switzerland.

PROFESSOR WILDER D. BANCROFT, of Cornell University, lectured before the students of science in the University of North Carolina on the evening of February 11 on 'Physical Chemistry and General Science.' On the morning of the twelfth he gave a lecture to special students in chemistry on 'Physical Chemistry and the Rare Earths.'

PROFESSOR CHARLES S. HASTINGS, of the Sheffield Scientific School, Yale University, lectured at the Woman's College of Baltimore, on March 14. The title of the lecture was 'A Lost Medieval Art,' Professor Hastings treating the subject of stained glass from a scientific standpoint. A reception by the physics department was given after the lecture.

UNDER the auspices of the Henry Phipps Institute for the Prevention of Tuberculosis, at Philadelphia, arrangements have been made with Dr. C. Maragliano, professor in the University of Genoa, and senator in the Italian parliament, to lecture on March 28, on 'The Serum Treatment for Tuberculosis.'

WE learn from *Nature* that a committee has been formed with the object of obtaining subscriptions for a memorial to the late Professor Nicol, in association with the University of Aberdeen, in which he taught for twenty-five years. The form the memorial should take has not been decided, but a suggestion has been made that if a memorial brass, similar to those erected to the memory of his predecessors, the late Professor Macgillivray and Nicholson, were provided, and placed with them in the University of Aberdeen, the ornithologist, stratigraphist and paleontologist who have brought honor to the university would be fittingly remembered in association with the scene and center of their life work. The secretary and treasurer, to whom subscriptions should be sent, is Dr. W. Mackie, 13 North Street, Elgin.

ARTHUR GREELEY, professor of biology at Washington University, St. Louis, died on March 15 after an operation for appendicitis.

MR. JOHN I. JEGI, B.S. (Chicago, 1896), professor of psychology and physiology in the Milwaukee State Normal School, died at his home in Milwaukee on January 7. Among his publications are 'A Syllabus of Human Physiology' (1901), 'Practical Lessons in Human Physiology' (Macmillan, 1903), and 'A Comparative Study of Auditory and Visual Memory,' in the 'Contributions to Philosophy' of the University of Chicago.

WE regret to record the death of M. F. A. Fouqué, of Paris, the well-known French geologist and mineralogist, on March 7, in his seventy-sixth year.

THE House of Lords has unanimously passed a bill making compulsory the metric system in Great Britain on April 5, 1906, or at such later date as may be directed by an order in council.

THE Washington *Star* states that the Fortifications Board of the War Department, which has appropriated $50,000 for the aerodrome experiments of Secretary S. P. Langley, has decided not to make further appropriations for this purpose.

THE Russian government has offered a prize of about $25,000 for the discovery of some method to make alcohol undrinkable.

THE fifteenth annual session of the Biological Laboratory of the Brooklyn Institute of Arts and Sciences will be held at Cold Spring

Harbor during the coming summer. Regular class work will begin on Wednesday, July 6, and continue for six weeks. Investigators may make arrangements for using the laboratory from the middle of June until the middle of September, or later, if desirous of doing so, but board at the laboratory will not be guaranteed after August 20. Application for admission to the laboratory should be made as early as possible, as the earlier applicants have the choice of rooms in the dormitories, and the number of students receiving instruction is limited to 50. The courses of instruction offered are as follows:

High-school Zoology by Professors C. B. Davenport, S. R. Williams and W. M. Wheeler.

Comparative Anatomy by Professor H. S. Pratt and Dr. D. B. Casteel.

Invertebrate Embryology by Professor H. E. Crampton and W. J. Moenkhaus.

Animal Bionomics and Evolution by Professor Davenport.

Cryptogamic Botany by Professor D. S. Johnson and Mr. A. H. Chivers.

Plant Ecology by Mr. Forrest Shreve, of Johns Hopkins University.

Microscopic Methods by Mrs. Davenport.

Courses in beginning investigations are offered, and advanced investigators are offered free use of rooms at the laboratory. The laboratory fee is $30 and room and board are furnished for $6 upward per week. Announcements and further information may be obtained from any of the instructors, or from Professor C. B. Davenport, University of Chicago.

The annual meeting of the Michigan Ornithological Club will be held at the museum of the University of Michigan, at Ann Arbor, on April 2, 1904, in connection with the meetings of the Michigan Academy of Science.

The thirty-eighth meeting of the Eastern Association of Physics Teachers was held in the Newton High School building on Saturday, March 19. Professor S. W. Stratton, director of the Bureau of Standards, Washington, D. C., read papers on 'The Metric System' and on 'The Equipment of Physical Laboratory Workshops.'

A conference of teachers of mathematics, well-attended and representing a large number of universities, colleges and high schools, was held on February 22, 1904, in Columbus, Ohio. This conference decided to form an association of Ohio teachers of mathematics and appointed committees to arrange for a meeting to complete the organization. This meeting will be held in Columbus at the Ohio State University on April 2, 1904. The conference extended an invitation to the teachers of physics and chemistry in Ohio to meet in Columbus with the teachers of mathematics to form a similar organization, with the suggestion that these several bodies be related in some desirable way under the name of 'The Association of Ohio Teachers of Mathematics and Science.'

The fifteenth International Medical Congress will meet at Lisbon April 19–26, 1906.

We learn from *The Geographical Journal* that a project has lately been set on foot for the bringing together into one building of all the scientific societies which have their headquarters in Edinburgh, and a meeting of the fellows of the Royal Society of Edinburgh in support of the proposed scheme was held in the society's rooms on November 26 last, the subject being introduced by a speech by Sir John Murray. The Royal Society occupies a portion of the building known as the Royal Institution, which it shares at present with other public bodies, including the Board of Fishery, the School of Art and the Society of Antiquaries of Scotland, the whole being under the general control of the Board of Manufactures. It has long been thought that the building should be exclusively devoted to scientific purposes, thus, on the one hand, securing a community of interests on the part of all its users, and, on the other, facilitating the work of scientific research by the centralization thus afforded and the avoidance of the dissipation of energy which is to a certain extent the result of the present separation of the societies. It is held that, were the whole building given up to their use, it would be possible to find space for the housing of all the several libraries, including those of the Scottish Geographical and Meteorological Societies, besides allotting to each the rooms required for other purposes, and leaving the

large central hall available for scientific demonstrations, lectures and the like. The proposal found warm support at the meeting alluded to, and a resolution in furtherance of the above-mentioned aims was unanimously adopted.

THE *British Medical Journal* states that a health resort is to be established in Lapland. It is proposed to erect a sanatorium on the shores of Lake Torne, a long and beautiful sheet of water at Wassijauve, near the end of the Ofote Railroad. That railroad, it may be mentioned, has only one station in a distance of 121 miles. There is no human dwelling near that station, which is on the line between Sweden and Norway, and was erected solely for the requirements of the Customs Office. Except for a small settlement at Wassijauve, the only sign of human existence in the district is the occasional passage of a few Laplanders with their herds of reindeer. Apart from the scenery, the inmates of the Arctic sanatorium will have no external object of interest but a scientific station which has been erected with the help of private subscriptions by men of science. The work pursued at the station includes biological, geological, botanical and entomological, and other investigations conducted during the summer, and meteorological, magnetic and other observations made at all seasons. The station is a solidly built block-house containing seven rooms, and it is proposed to build the sanatorium in the same way.

THE *Scottish Geographical Magazine* reports that the 'Société Belge d'Astronomie,' has announced a scheme for the publication of a monograph on volcanoes. This will consist of an atlas containing a general map on the scale of 1:40,000,000, and ten regional maps on the scale of 1:2,000,000, illustrating the general distribution of volcanoes, together with a notice, detailed descriptive tables and block-maps in the text. It is estimated that the text and tables together will occupy about 300 pages, large 8vo. The undertaking will be under the charge of M. Elisée Reclus. In order that the success of this undertaking may be assured, subscriptions are asked for in advance. A subscription of 25 francs will entitle the subscriber to one ordinary copy of the atlas, and one of 100 francs to two copies printed on special paper and numbered. Communications should be addressed to the Society at 21 Rue des Chevaliers, Brussels.

UNIVERSITY AND EDUCATIONAL NEWS.

SIR DONALD CURRIE has given £100,000 to University College and London University. It is intended with this sum to build a school of advanced medicine.

MR. ANDREW CARNEGIE has given $50,000 to Kenyon College to endow a professorship of economics to be named for Edwin M. Stanton, three years a student of Kenyon, who once said: "If I am anything or have done anything in the way of usefulness, I owe it to Kenyon College." The gift is said to be due to an interview with the late Senator Hanna when sick, who himself had given $50,000 to Kenyon College for a dormitory just now finished.

MR. CARNEGIE has also made a conditional gift of $50,000 to Mt. Holyoke College, the understanding being that the friends of the institution should raise a like amount before June 1. No stipulations are made regarding the use of the money, but it is said that a new library is contemplated.

PLANS have been accepted for the science building given to Rochester University by Mr. George Eastman, of Rochester, at a cost of $60,000, the construction of which will be begun during the summer.

THE new medical laboratories of the University of Pennsylvania will be dedicated on June 11. The laboratories cost $700,000. The principal addresses will be delivered by Dr. H. P. Bowditch, professor of physiology at the Harvard Medical School; Dr. R. H. Chittenden, director of the Sheffield Scientific School, Yale University; Dr. George Dock, professor of medicine at the University of Michigan, and Dr. Horatio C. Wood, professor of materia medica and pharmacy at the University of Pennsylvania.

IT is reported that a plan has been suggested to unite the Columbian and American Universities of the District of Columbia and the

interests favoring a national university, to form the nucleus of a great national university at the capital. The trustees of the American University, with its endowment of $2,000,000 and its tract of ground in the northwestern suburbs, have discussed the project. Bishop McCabe, the head of the university, has spoken favorably of the idea. President Needham, of the Columbian University, and a number of the other officers of that institution have expressed a willingness to meet the officers of the American University to consider the project. It is probable that within the next few months a meeting of the different interests will be had. It is suggested by friends of the plan that such a merger would retain at least one of the strong features of each of the chief institutions and would give much greater financial strength. The plan, however, is chiefly for the establishment of university post-graduate work.

At the meeting of the Association of American Universities held in New Haven on February 18–20, the University of Virginia was elected to membership in that association.

The administrative council of the French Association for the Advancement of Science has offered to defray the cost of a course on physical astronomy at the University of Paris, which will be given by M. Pierre Puiseux, astronomer of the observatory at Paris.

Mr. Edward M. Shepard has been elected chairman of the board of trustees of the College of the City of New York, in place of Mr. Edward Lauterbach, who resigned to accept the position of regent of the University of the State of New York.

Associate Professor Charles B. Davenport, of the department of zoology of the University of Chicago, has resigned to accept the appointment, to which we have already called attention, from the Carnegie Institution as head of the department of experimental biology, which, for the present, is to include a marine station on the Tortugas and a Laboratory for Experimental Evolution at Cold Spring Harbor, Long Island. Professor Davenport is to be in immediate charge of the latter. The buildings in connection with the laboratory are now in process of erection under the direction of Dr. Davenport, who is absent on a vacation during the winter quarter. He will spend the spring quarter at the university and will then leave to take permanent charge of the new laboratory.

Professor L. V. Pirsson, of the chair of physical geology, has been chosen to fill temporarily the curatorship of the geological collection of the Peabody Museum, Yale University, made vacant by the death of Professor C. E. Beecher.

Professor L. H. Bailey, of Cornell University, will superintend the nature study courses in the summer session at the University of Tennessee.

E. V. Huntington, Ph.D., and J. H. Woods, Ph.D., have been appointed instructors at Harvard University in mathematics and philosophy respectively.

The Smith's prizes at Cambridge University have been adjudged as follows: E. Cunningham, B.A., St. John's College, for his essay 'On the Normal Series satisfying Linear Differential Equations'; J. C. M. Garnett, B.A., Trinity College, for his essay 'On the Cause of Color in Metal Glasses and Metallic Films'; H. A. Webb, B.A., Trinity College, for his essay 'On the Expansion of an Arbitrary Function in a Series of Functions'; P. W. Wood, B.A., Emmanuel College, for his essay 'On Covariant Types.'

At University College, London, Dr. G. Dawes Hicks has been appointed to the chair of moral philosophy; Dr. E. R. Edwards, lecturer in phonetics for a term of three years; Dr. H. Batty Shaw, lecturer in therapeutics, and Mr. Percy Fleming, professor of ophthalmic medicine and surgery, in succession to Professor Tweedy, resigned.

Mr. J. J. E. Durack, B.A. (Sydney), B.A. (Research, Cambridge), has been appointed demonstrator in natural philosophy at King's College, London.

M. Fernbach has been placed temporarily in charge of a course in biological chemistry at the Sorbonne, Paris, in place of M. Duclaux, who has been given leave of absence on account of his health.